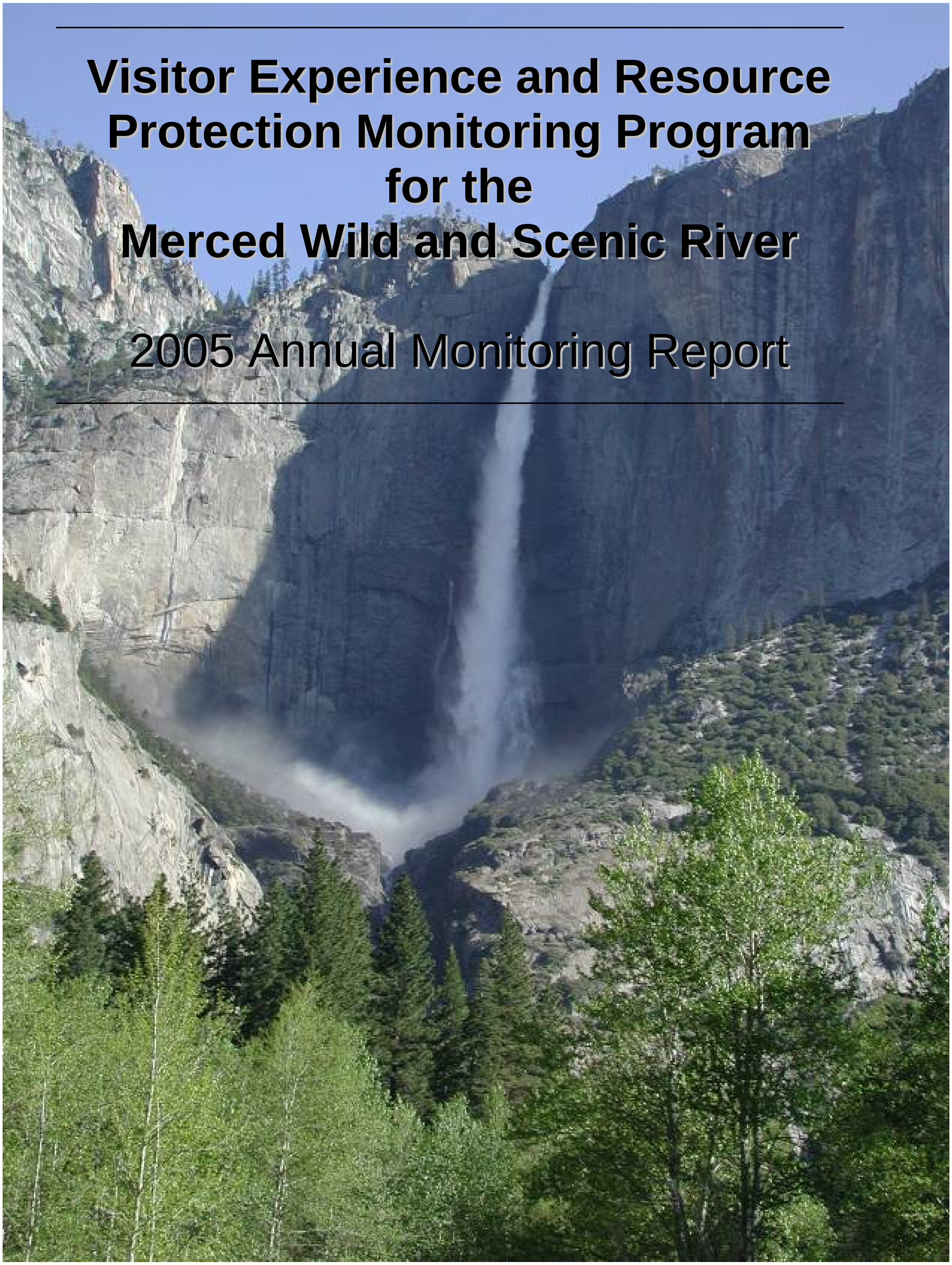
Visitor Experience and Resource Protection Monitoring Program for the Merced Wild and Scenic River

2005 Annual Monitoring Report



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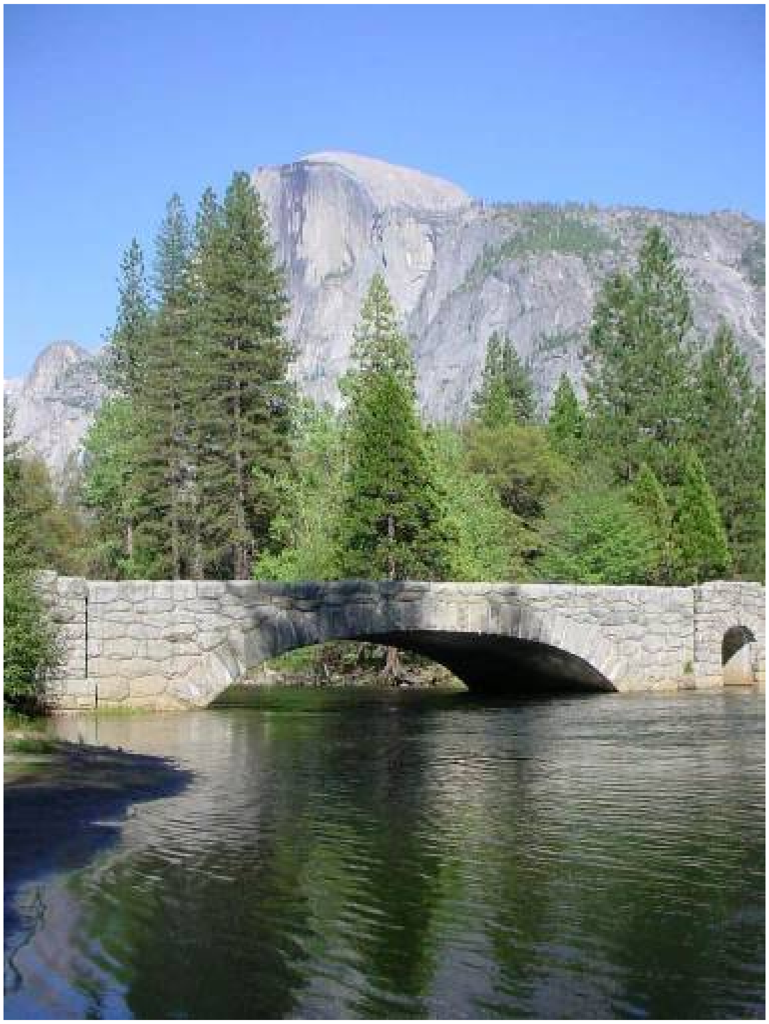

National Park Service
United States Department of the Interior

Yosemite National Park
California

EXECUTIVE SUMMARY

This was the second year of Visitor Experience and Resource Protection (VERP) monitoring program development and implementation for the Merced Wild and Scenic River. Indicators and standards were improved upon from 2004; field monitoring and data collection was repeated; two workshops were held to evaluate and refine monitoring protocols and program administration; and quarterly reports were provided to inform the public of the program's progress.

Results from indicator monitoring in 2005 are as follows:

- **Water Quality:** Preliminary results suggest excellent water quality along both the Main Stem and South Fork of the Merced River. Data collection will continue and standards will be established once a sufficient sample size has been obtained.
- **Number of Social Trails:** Social trails were re-documented at three wetland area sample sites and an increase in the number of social trails was reported at one road-side pull-out. Due to methodological concerns, monitoring of this indicator will be suspended in 2006. Instead, social trail impacts will be addressed using the length of social trails protocol.
- **Length of Social Trails:** Repeated social trail mapping in 2005 revealed an overall increase in the length of trails in Cooks and El Capitan meadows. Funding is being sought for restoration work in El Capitan meadow. Additional monitoring and validation of impacts will be conducted for Cooks meadow. Monitoring of this indicator will continue in 2006 with modifications to the protocol toward making measurement more efficient and cost-effective.
- **Wildlife Exposure to Human Food:** The Ahwahnee and Curry Village parking areas and the Camp 4 and Housekeeping Camp areas reported below standard compliance rates with food storage regulations in 2005. Monitoring of this indicator will continue in 2006 with refinements.
- **Riverbank Erosion:** Data collection in 2005 established a baseline for riverbank erosion conditions. An index was developed representing overall riverbank condition. This information has been incorporated into a map which will be used to identify key areas for monitoring in 2006.
- **Ethnobotany:** This was a pilot indicator in 2005 integrating natural and cultural resource values in the Merced River corridor. Both scientific and practitioner assessments of traditionally gathered plant resources were conducted. Development of this indicator is expected to continue in 2006.
- **Wilderness Encounters:** The remoteness of Wilderness has made it difficult to obtain a sufficient sample size from which to draw accurate conclusions regarding encounter rates. Nevertheless, 2005 data suggest relatively low encounter rates overall with more frequent encounters in the trailed wilderness segments versus the un-trailed. Monitoring of this indicator will continue in 2006 with refinements.
- **People At One Time along the River:** Monitoring in 2005 produced a baseline of river use data at selected sites. These sites represent low, medium and high use areas of the river. A diversity of activities was observed and use fluctuated throughout the course of the day. Monitoring of this indicator will continue in 2006.
- **Parking Availability:** The day-use parking area filled to capacity a significant number of days each month throughout the peak summer season of 2005. Significant improvements to this indicator are likely in 2006.
- **Facilities Availability:** Monitoring in 2005 suggests that visitors are able to find an open picnic table the vast majority of time at selected day use and outdoor eating facilities sampled. Monitoring of this indicator variable is expected in 2006 with refinements.

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1. INTRODUCTION

The following report presents field monitoring results and programmatic advancements of the Visitor Experience and Resource Protection (VERP) monitoring program in 2005. This year marked the second year in the development and implementation of an ongoing monitoring program to support user capacity management of the Merced Wild and Scenic River in Yosemite National Park (YOSE 2004).

1.1. BACKGROUND

The Organic Act established the National Park Service to, "conserve the scenery and the natural and historic objects and the wild life therein" while at the same time providing for "the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (NPS Organic Act 1916 - 16 USC 1). Thus, park planners and managers are charged to protect resources while providing for their enjoyment. How do we strike this balance?

VERP is a planning and management framework developed by the National Park Service to address human use and related issues in units of the National Park system, or what has traditionally been considered carrying capacity (Hof et al. 1994, NPS 1995, NPS 1997). As applied to parks and recreation, *carrying capacity* refers to the level of visitor use that can be accommodated while sustaining acceptable resource and social conditions that compliment the purpose of a park (NPS 1997). This definition implies that carrying capacity is primarily a prescription for desired resource and social conditions and secondarily a prescription for the appropriate numbers of people.

The VERP framework is an iterative process consisting of nine elements. These elements include both planning and management activities. Figure 1 below displays a summary of the framework. Fundamentally, the process consists of 1) defining desired conditions for park resources and human experiences, 2) developing indicators and standards of quality to monitor the condition of park resources and human experiences, and 3) taking management action to ensure desired conditions and experiences are maintained.

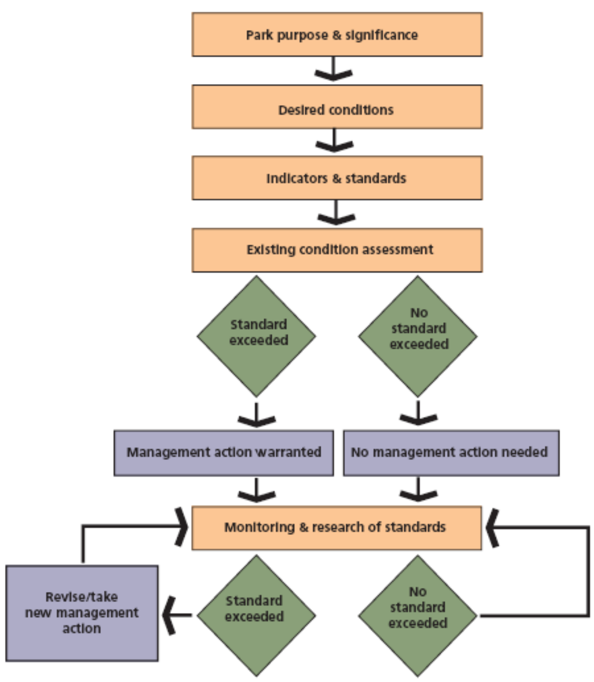

Figure 1: VERP Framework.

The 1978 National Parks and Recreation Act mandates that the National Park Service address carrying capacity in general management plans (P.L.95-625). Yosemite recently undertook a revision of the Merced Wild and Scenic River Plan. Wild and Scenic River Plans are considered to be on the scale of park general management plans, providing general guidance for the management of a designated Wild and Scenic River. Therefore, the VERP framework was applied to the Merced River through this planning process to address carrying capacity issues associated with the management of the river corridor. Additional background and detailed information on the application of the VERP framework to the Merced River corridor can be found in the Merced Wild and Scenic River Comprehensive Management Plan and Supplemental EIS (YOSE 2005) and the User Capacity Management Plan for the Merced Wild and Scenic River (YOSE 2004).

As mentioned above, the geographic focus of the VERP program described in this report is the Merced River Corridor through Yosemite National Park including the Main Stem and South Forks of the river (see figure 2).

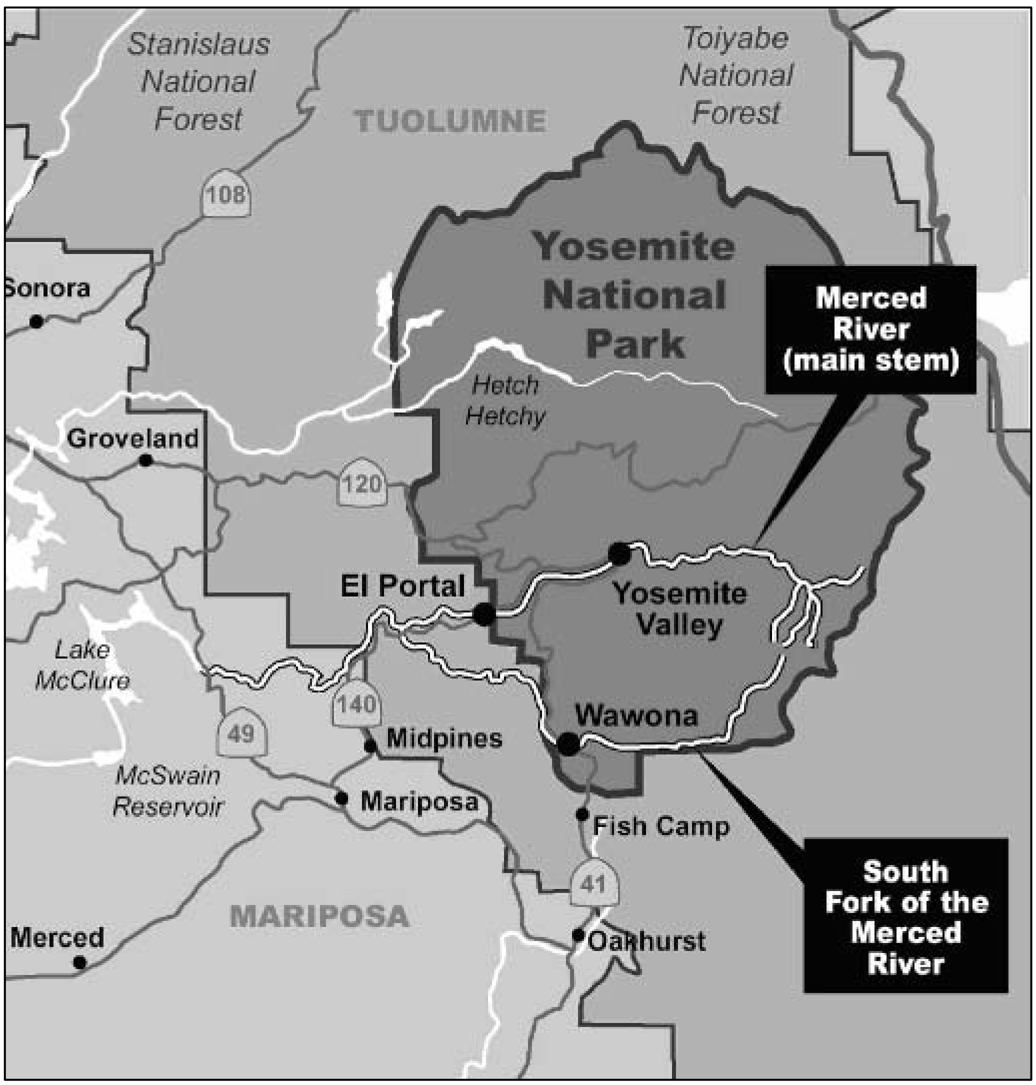

Figure 2. Map of Yosemite National Park.

1.2. PROGRAM DEVELOPMENT

Implementation of the VERP monitoring program began in 2004 and significant effort has been put into developing indicators, standards, and monitoring protocols. Results from this initial effort can be found in the 2004 VERP Annual Report (YOSE 2005).

Indicators are measurable, manageable variables that reflect the condition of park resources and visitor experiences, while standards represent the desired condition of indicator variables (Manning 1999). Monitoring indicator variables provides important information to park planners and managers on the condition of park resources and human experiences (Hof and Lime 1997). Collectively, defining indicator variables, setting standards, and monitoring serve as an early warning system informing park managers of potentially unacceptable changes in resource and social conditions.

A set of eleven indicators were tested in 2004. During program evaluation (described in Section 4 of this report), however, several indicators were considered less effective than desired and were replaced with different indicators. Consequently, several new indicators were piloted in 2005. Table 1 below presents a list of the indicators and standards employed this year.

Table 1. Indicators and standards in 2005.

Indicators	Standards
Number of encounters with other parties in Wilderness	Zone 1A: No more than 1 encounter with another party per hour, 80% of the time. Zone 1B: No more than 1 encounters with another party per 4 hour period, 80% of the time.
Number of People At One Time (PAOT) along the river	To be determined.
Occupied parking versus capacity	The number of instances (time) when designated parking is full (requiring alternative parking actions) will occur on no more than *X* days per year (season) and *X* hours on average/day (for visitors, transit buses, and commercial tour buses). (**NOTE:** ***X represents the number of days and number of hours respectively. The standard is yet to be determined.***)
Availability of day use facilities	Visitors are able to find an open table 70% of the time during peak hours—June through October—at outdoor concession food service areas and park day use picnic areas. Baseline to be established from data collected during 2005.
Wildlife exposure to human food	95% or greater compliance with food storage regulations in selected campgrounds and parking areas.
Number of informal (social) trails	No net increase in number from 2004 baselines. No social trails for wetland features.
Length of informal (social) trails in meadows	No net increase in length from 2004 baseline.
Riverbank erosion	No net increase over 2005 baseline in linear extent of river bank erosion; no riverbank erosion exceeds Condition Class 2.
Extent/magnitude of four plant species used by local tribal groups	No alteration of characteristics of the traditional cultural resources that make them eligible for listing on the National Register of Historic Places. Specific standards to be determined.
Water quality: total dissolved nitrogen, phosphorus and fecal coliform content	Anti-degradation for each segment, for fecal coliform, nutrients (total nitrogen and total phosphorus), and petroleum hydrocarbons per sampling period. Absolute minimum, all segments: State fecal coliform standard for recreational contact at all times.

New indicators this year include 1) the health and condition of traditionally gathered plant species, 2) availability of day use facilities, 3) parking availability, and 4) people at one time (PAOT) along the river.

Due to scheduled maintenance to the cables and trail on Half Dome, the number of people at one time (PAOT) along trails was not monitored in 2005 and is not presented in this report.

In both 2004 and 2005 the VERP monitoring program followed a timeline similar to that represented in Figure 3 below. Generally, the late winter and early spring months are spent refining and improving monitoring protocols. In the spring preparations are made for data collection including hiring field staff; recruiting and organizing volunteers; preparing data sheets and finalizing protocols; checking and obtaining equipment, etc. The majority of data collection efforts take place during the summer and early fall. In the fall data are coded, analyzed and incorporated into a draft report. The annual report is finalized during winter months concluding the program year.

<table>
<tr><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>June</th><th>July</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td colspan="3">Complete Annual Report and Action Plan from previous year</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="4">Refine monitoring protocols, prepare for new field season, Spring workshop</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="6">Finalize Field Monitoring Guide, conduct field monitoring and collect data</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Compile and analyze data, report writing, Fall workshop</td></tr>
<tr><td colspan="3">Progress report</td><td colspan="3">Progress report</td><td colspan="3">Progress report</td><td colspan="3">Progress report</td></tr>
<tr><td colspan="12">Implement management actions throughout as stipulated in action plan</td></tr>
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Figure 3. VERP program timeline.

1.3. REPORT SUMMARY

This Annual Report presents VERP monitoring program activities and data collection results for the 2005 calendar year. It is organized into the following sections: A) Introduction, B) Monitoring Results, C) Program Evaluation and Summary, D) Appendices. Section B presents descriptive results from field monitoring and data collection for each indicator variable. New this year is the program evaluation chapter (Section C). This section is intended to provide information on the evaluation and continued development of the VERP program. Since it is an iterative process, continued evaluation and development are integral to the program's success. Section D describes evaluative measures taken to improve upon the monitoring program.

2. MONITORING RESULTS

This section presents the findings from indicator monitoring in 2005. Results are organized by indicator variable with each presenting the following information: indicator and standard description; indicator performance summary; monitoring activities; results; discussion; and management implications.

2.1. WATER QUALITY

Excellent water quality was identified by the Merced River Plan as part of the hydrologic processes Outstandingly Remarkable Value in three segments of the river corridor: in the wilderness reaches of the main stem and South Fork, as well as in the impoundment segment of the South Fork (above Wawona).

Water quality sampling on the Merced River initiated in June 2004 continues and results through October 2005 are incorporated into this report. Nutrient concentrations were generally quite low, often below the reporting limit for the analytical method. Table 2 summarizes the analytical methods used and any applicable standards. For comparison purposes, the highest values of Nitrate + Nitrite, sampled at Foresta Bridge in El Portal, contained between 0.58 and 0.71 mg/l.

Bacteriological content of Merced River waters has also been quite low with the exception of a single value of 291 MPN/100 ml (Most Probable Number of bacteria colonies per 100 ml) sampled at Pohono Bridge on May 24th, 2005. The cause of the high value is unknown and samples taken before and after this time at Pohono Bridge ranged from less than 1 to 24 MPN/100 ml. Total petroleum hydrocarbon concentrations have been very low, with most samples containing less than the 13 ug/l required for detection.

Table 2. Water quality constituents sampled in 2005.

Constituent	Analytical Method	Analytical Reporting Limit	California Standard	Source Document
Total Dissolved Nitrogen	USGS/NWQL[1] 2754	0.06 mg/l	None	
Nitrate + Nitrite	USGS/NWQL[1] 1979	0.016 mg/l	10 mg/l (Drinking water)	California Department of Health Services – Maximum Contaminant Levels
Total Phosphorous	USGS/NWQL[1] 2333	0.004 mg/l	None	
Total Dissolved Phosphorous	USGS/NWQL[1] 2331	0.004 mg/l	None	
E. coli	SM 9221F[2]	2 MPN/100ml (MPN = Mean Probable Number of bacterial colonies)	Geometric Mean of 5 samples taken over a 30-day period shall not exceed 126 MPN/100 ml. No single sample shall exceed 235 MPN/100 ml.	State of California, 1998. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region. Fourth Edition—1998. California Regional Water Quality Control Board.
Total Petroleum Hydrocarbons	EPA 306M[3]	13 µg/l	Waters shall not contain oils, greases, waxes, or other materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.	State of California, 1998. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region. Fourth Edition—1998. California Regional Water Quality Control Board.

[1] U.S. Geological Survey National Water Quality Laboratory
[2] Standard Method
[3] Environmental Protection Agency Standard Method

Measurement: Water quality monitoring explored for the following water contaminants: fecal coliform, dissolved nitrogen, dissolved phosphorus and petroleum hydrocarbons.

Zones:

- 1D Designated Overnight
- 2A Open Space
- 2C Day Use
- 2D Attraction
- 3A Camping
- 3B Visitor Base and Lodging
- 3C Park Operations and Administration

Standards: Anti-degradation for each segment for fecal coliform, nutrients (total nitrogen and total phosphorus), and petroleum hydrocarbons per sampling period. Absolute minimum, all segments: State fecal coliform standard for recreational contact at all times.

Sampling: Field staff sampled at ten locations monthly on the Merced River and South Fork (Figure 4) in coordination with state-mandated water quality sampling conducted by Park utilities personnel at the waste water treatment plants in Wawona and El Portal. In addition, several storm events where sampled including spring run-off. The latter was conducted weekly for a period of ten weeks. Nutrients (total dissolved nitrogen, nitrate, total phosphorous and total dissolved phosphorous) were sampled at all sites. E. coli was sampled only at front-country sites due to the maximum six-hour hold time for these samples. Total petroleum hydrocarbons were sampled at three locations downstream of developed areas. In addition to collecting samples, field staff measured water temperature, specific conductivity, pH, and dissolved oxygen as well as river stage where possible.

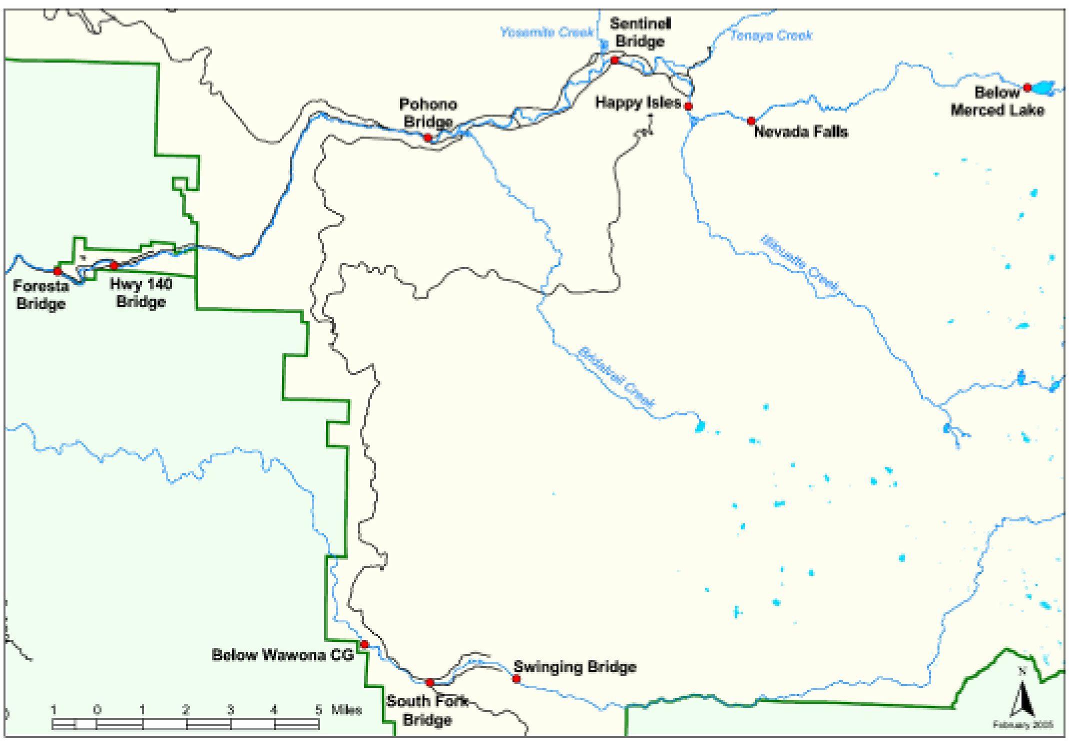


Figure 4. Merced River water quality sampling locations.

Results: Nutrient data are plotted for each sampling station in Figures 5a-h below. Concentrations of sampled nitrogen species, total dissolved nitrogen (TDN) and nitrate plus nitrite (NO3 + NO2), were generally well below 0.1 milligrams per liter (mg/l) with higher values during low water and early fall storms. The highest concentrations have been observed at the Foresta Bridge in El Portal and have been associated with low water conditions in September and October. Maximum nitrate plus nitrite concentrations of 0.58 – 0.71 mg/l have been observed in October 2004 and 2005. These values are well below the Maximum Contaminant Level (MCL) standard of 10 mg/l for drinking water.

Total Phosphorous (TP) and Total Dissolved Phosphorous (TDP) were consistently low, often below the reporting limit of 0.004 mg/l (Figure 2).

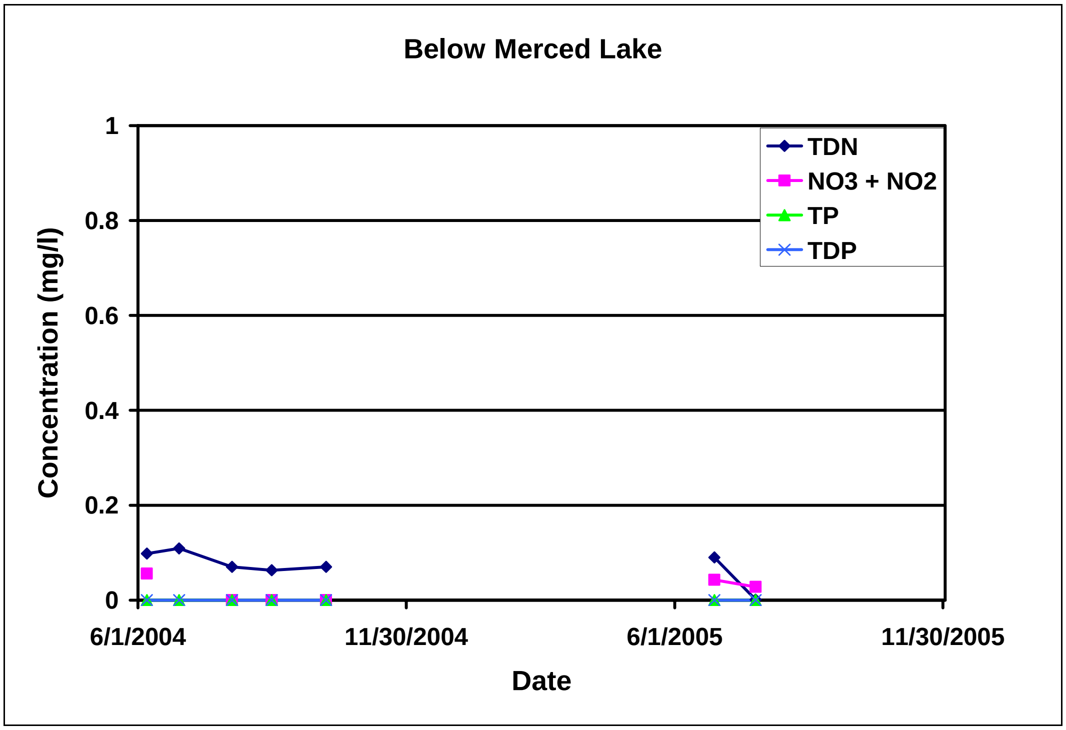


Figure 5a. Summary Nutrient Data (June 2004 – October 2005). Gaps indicate periods of no data collection. Non-detectable concentrations have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

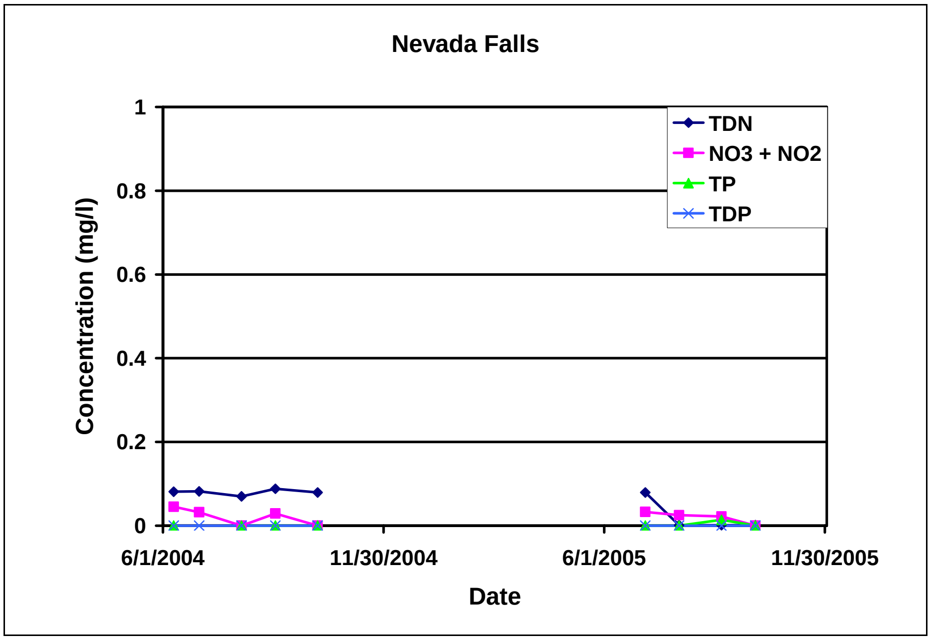


Figure 5b. Summary Nutrient Data (June 2004 – October 2005). Gaps indicate periods of no data collection. Non-detectable concentrations have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

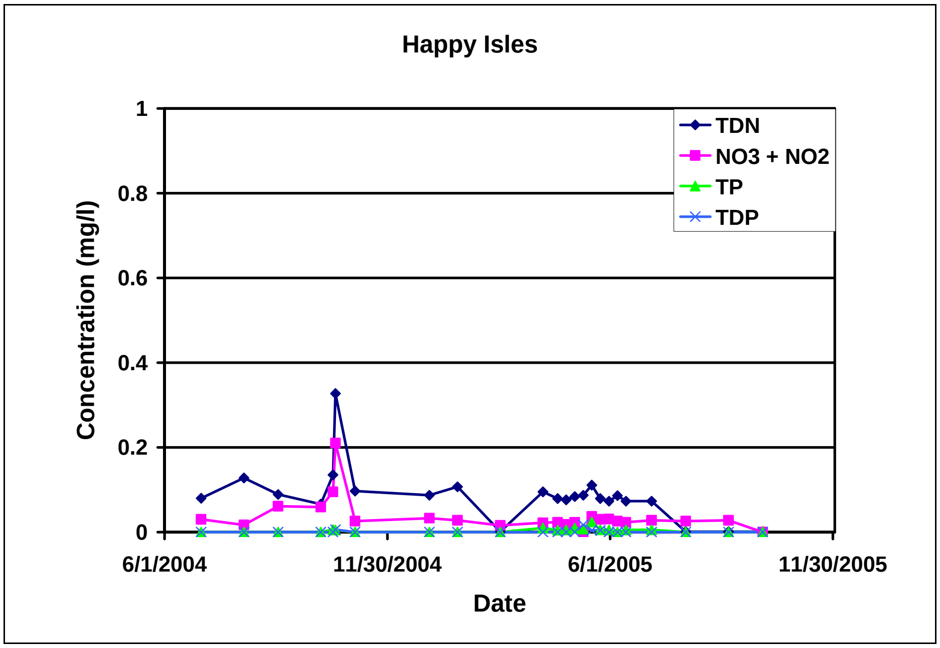


Figure 5c. Summary Nutrient Data (June 2004 – October 2005). Gaps indicate periods of no data collection. Non-detectable concentrations have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

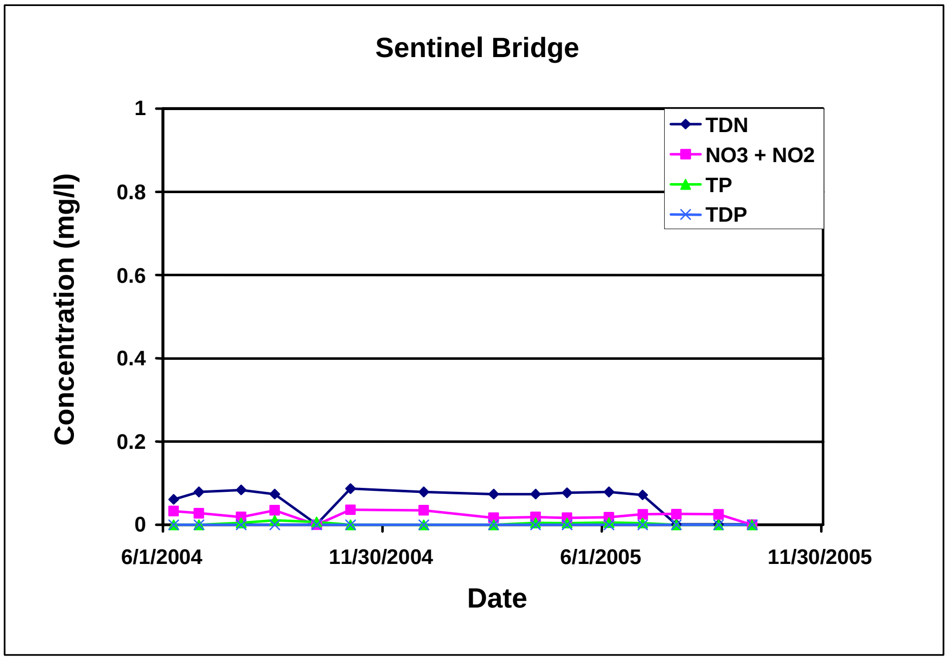


Figure 5d. Summary Nutrient Data (June 2004 – October 2005). Gaps indicate periods of no data collection. Non-detectable concentrations have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

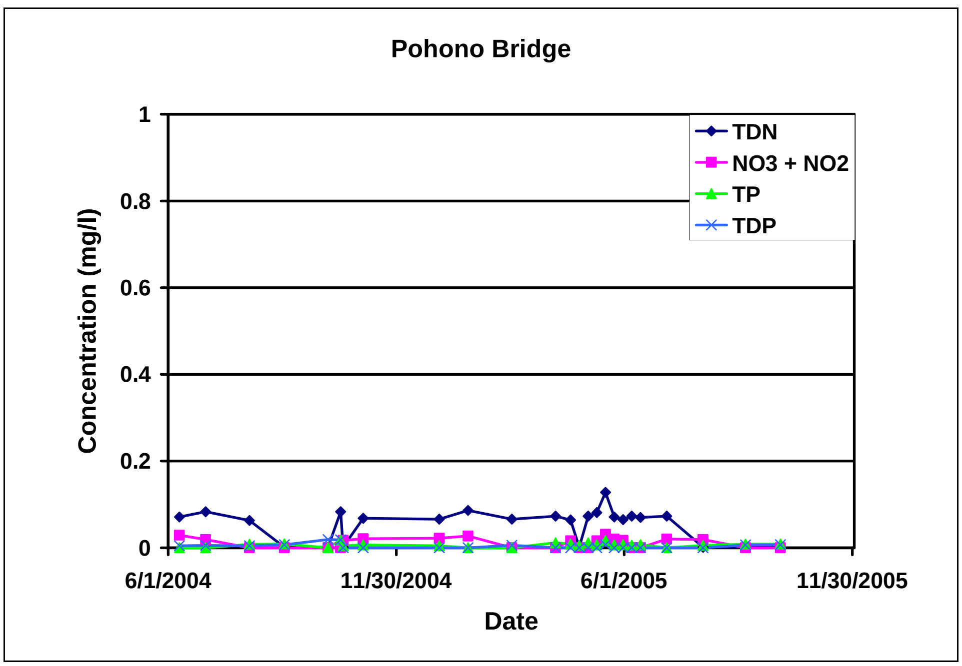


Figure 5e. Summary Nutrient Data (June 2004 – October 2005). Gaps indicate periods of no data collection. Non-detectable concentrations have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

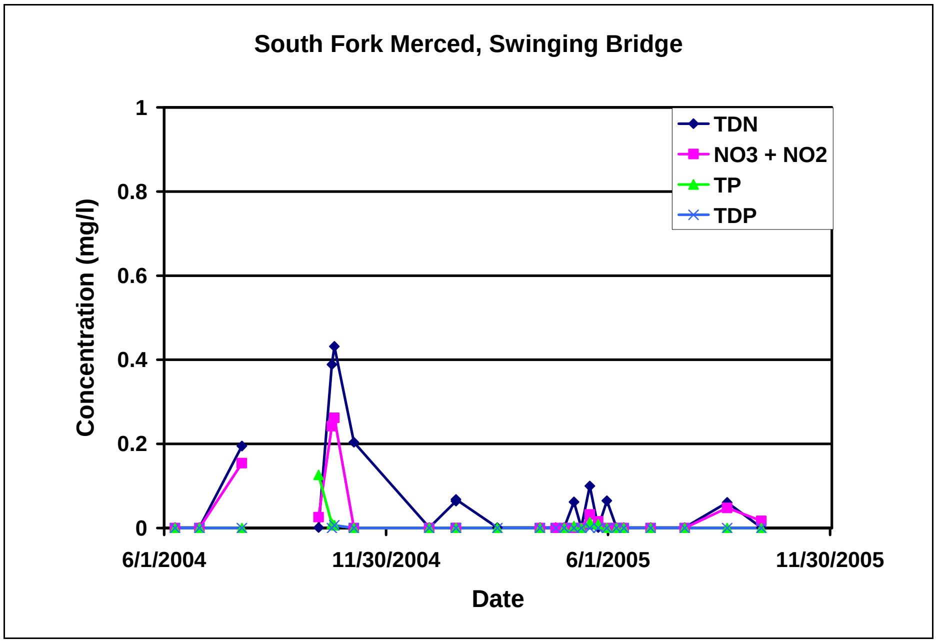


Figure 5f. Summary Nutrient Data (June 2004 – October 2005). Gaps indicate periods of no data collection. Non-detectable concentrations have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

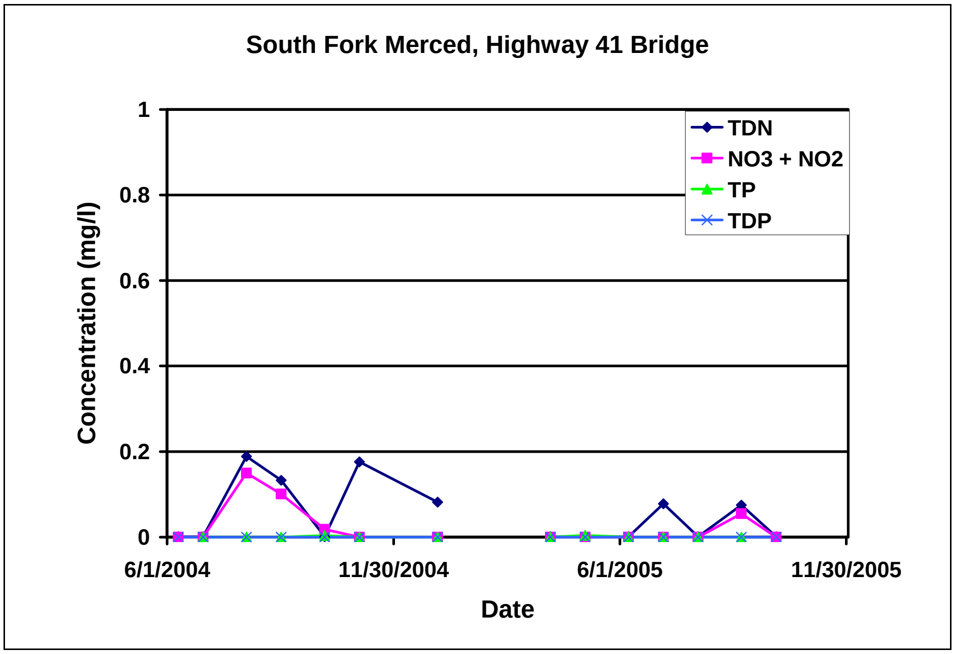


Figure 5g. Summary Nutrient Data (June 2004 – October 2005). Gaps indicate periods of no data collection. Non-detectable concentrations have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

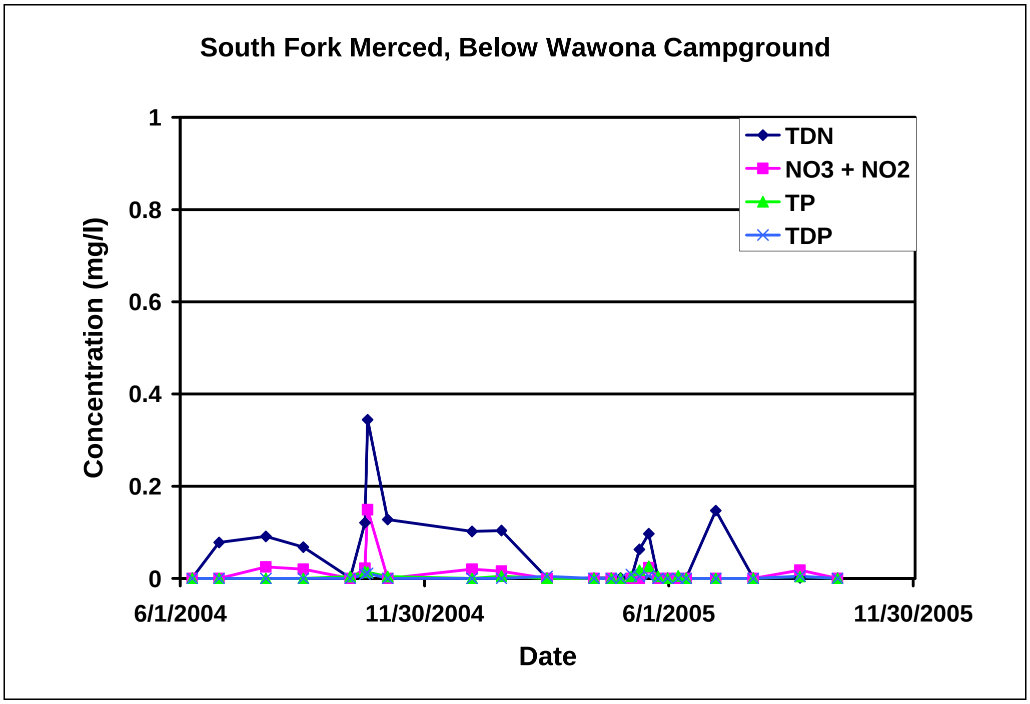


Figure 5h. Summary Nutrient Data (June 2004 – October 2005). Gaps indicate periods of no data collection. Non-detectable concentrations have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

Measurement of bacterial contamination via fecal coliform was replaced with *E. coli* (a subset of fecal coliform) in order to be consistent with state recommendations and the availability of analytical facilities at the El Portal Wastewater Treatment facility. Since this switch in April 2005, measured concentrations of *E. coli* has been consistently low (Table 3) at all locations with the exception of a single sample taken on May 24, 2005 at Pohono Bridge which measured 291 MPN/100 ml. The cause of the high value is unknown and samples taken before and after this time at Pohono Bridge ranged from less than 1 to 24 MPN/100 ml.

Table 3.Summary of *E. coli* data, April - October, 2005.

Site Name	Date	*E. coli* (MPN/100ml)*
Merced River above Happy Isles Bridge	4/19/2005	2
	4/26/2005	<1
	5/3/2005	2
	5/10/2005	1
	5/17/2005	25
	5/24/2005	5
	6/7/2005	<1
	6/14/2005	38
	7/5/2005	6
	8/2/2005	6
	9/6/2005	21
	10/4/2005	<1

Site Name	Date	*E. coli* (MPN/100ml)*
Merced River above Sentinel Bridge	5/3/2005	5
	6/7/2005	3
	7/5/2005	5
	8/2/2005	10
	9/6/2005	4
	10/4/2005	20
Merced River above Pohono Bridge	4/19/2005	12
	4/26/2005	<1
	5/3/2005	7
	5/10/2005	5
	5/17/2005	24
	5/24/2005	291
	6/7/2005	<1
	6/14/2005	20
	7/5/2005	4
	8/3/2005	3
	9/6/2005	11
	10/4/2005	8
Merced River above SR140 Bridge	6/7/2005	<1
	7/5/2005	5
	8/2/2005	<1
	9/6/2005	<1
	10/4/2005	<1
Merced River above Foresta Bridge	4/19/2005	<1
	4/26/2005	<1
	5/10/2005	4
	5/17/2005	34
	5/24/2005	5
	6/7/2005	2
	6/14/2005	19
	7/5/2005	2
	8/2/2005	2
	9/6/2005	1
	10/4/2005	<1
S. Fork Merced River above Swinging Bridge	4/19/2005	<1
	4/26/2005	1
	5/4/2005	<1
	5/10/2005	<1
	5/17/2005	1
	5/24/2005	1
	6/8/2005	<1
	6/14/2005	<1
	7/6/2005	1
	8/3/2005	1
	9/7/2005	3

Site Name	Date	*E. coli* (MPN/100ml)*
	10/5/2005	<1
S. Fork Merced River above South Fork Bridge	5/4/2005	1
	6/8/2005	1
	7/6/2005	4
	8/3/2005	<1
	9/7/2005	13
	10/5/2005	2
S. Fork Merced River below Wawona Campground	4/19/2005	<1
	4/26/2005	1
	5/4/2005	1
	5/10/2005	1
	5/17/2005	3
	5/24/2005	<1
	6/8/2005	4
	6/14/2005	4
	7/6/2005	6
	8/3/2005	3
	9/7/2005	4
	10/5/2005	<1

*Most Probable Number (of colonies) per 100 milliliters

Measurement of Total Petroleum Hydrocarbons via EPA method 1664, which had a detection limit of 2 mg/l, was replaced in January 2005 with the much more sensitive EPA 306M with a detection limit of 13 µg/l. Though most samples contained less than the detection limit, those samples containing petroleum hydrocarbons contained between 13 and 39 µg/l (Table 4).

Table 4. Summary of total petroleum hydrocarbon data, Jan - Oct, 2005 (ND = non-detect).

Site Name	Date	Total Petroleum Hydrocarbon Concentration (µg/l)
Merced River above Pohono Bridge	1/4/2005	39
	1/27/2005	ND
	3/3/2005	ND
	4/7/2005	25.7
	4/19/2005	ND
	4/26/2005	ND
	5/3/2005	ND
	5/10/2005	23
	5/17/2005	22.4
	5/24/2005	14.2
	5/31/2005	ND
	6/7/2005	ND
	6/14/2005	ND
	7/5/2005	ND
	8/3/2005	ND
	9/6/2005	ND
	10/4/2005	ND

Site Name	Date	Total Petroleum Hydrocarbon Concentration (µg/l)
Merced River above Foresta Bridge	1/4/2005	25
	1/27/2005	ND
	3/3/2005	ND
	4/7/2005	22.2
	4/19/2005	ND
	5/10/2005	ND
	5/17/2005	16.5
	5/24/2005	ND
	5/31/2005	ND
	6/7/2005	ND
	6/14/2005	ND
	7/5/2005	ND
	8/2/2005	ND
	9/6/2005	ND
	10/4/2005	ND
S. Fork Merced River below Wawona Campground	1/5/2005	22
	1/27/2005	ND
	3/2/2005	ND
	4/6/2005	18.3
	4/19/2005	ND
	4/26/2005	ND
	5/4/2005	ND
	5/10/2005	ND
	5/17/2005	32
	5/24/2005	13.8
	5/31/2005	ND
	6/8/2005	ND
	6/14/2005	ND
	7/6/2005	ND
	8/3/2005	ND
	9/7/2005	ND
	10/5/2005	ND

Discussion: Approximately 50% of sampling necessary to establish baseline conditions on the Merced River and the South Fork of the Merced has been completed. Data presented in this report will be used to construct water quality standards when the sample size for each location and constituent will be sufficient to be statistically robust. An example of a standard could be the 80^{th} percentile value for a particular constituent.

Nutrient concentrations at all sample sites were low, even during low water, storm, and spring runoff conditions. Sampling frequency may be decreased, particularly for phosphorous species in order to examine other aspects of water quality affected by visitor use (see recommendations).

The switch to measuring *E. coli* has greatly increased data gathering efficiency because samples can be analyzed in El Portal rather than having to be driven to Fresno. *E. coli* concentrations were quite low with the exception of the Pohono Bridge sample mentioned earlier. Examination of earlier and later samples indicates that this was either a sampling error or an isolated event. Values of *E. coli* are not directly comparable to earlier fecal coliform data (VERP 2004). However, they are consistent with state recommendations for assessment of health hazards associated with recreational contact with surface waters. Sampling of this constituent will continue at the present frequency.

Sampling for petroleum hydrocarbons using a more sensitive analytical method successfully revealed extremely low concentrations in park waters. Sample frequency of this constituent will probably be decreased in order to conserve funds. Petroleum hydrocarbons will likely be sampled quarterly, during storm events, and following paving activities along park roads.

All data to date indicate very good water quality along the main stem and South Fork of the Merced River. Funds secured through a cooperative USGS/NPS grant will allow further characterization of water quality such as measuring turbidity and automated sampling of storm events. The latter will allow sampling as the river rises during a storm, the period often associated with the highest nutrient concentrations. (At present, logistical considerations often limit sampling to the period after a storm as the river levels fall.) Remaining baseline sampling along with these additional investigations will permit establishment of sound water quality standards for the future.

2.2. NUMBER OF SOCIAL TRAILS

Social trails are the pathways that humans wear into the ground through repeated use. These trails are regarded as “social” because they are not formal, designated pathways, but are created from human social behavior. For example, consider when a hiking party side-cuts an established trail leaving the vegetation trampled down. A subsequent party identifies this as an established path and also follows it, creating additional impact. In this manner social trails proliferate and can cause negative impacts to the ecosystem (Marion and Leung 2004) and the quality of the visitor experience (Manning et al. 2005).

The Open Space and Undeveloped Open Space zones (2A and 2A+) include the relatively inaccessible and undisturbed canyon rims and walls along the gorge of the main stem of the Merced River and below Wawona along the South Fork of the Merced River. In addition, the fen near Happy Isles and Wosky Pond below El Capitan are included in Zone 2A. These areas receive limited use associated primarily with access to climbing routes. Social trails are an indicator of that incidental use. As use increases, the number of social trails will also increase. Tracking the number of social trails will give the park an indication of the level of use that is occurring and whether or not that use is increasing. In the case of the two wetlands, any social trails could lead to disruption of the ecological processes.

The number of social trails is indicative of the contiguity and ecological health of meadows and wetland areas (part of the biological Outstandingly Remarkable Value). It is also indicative of impacts to wildlife habitat, including special-status species (biological Outstandingly Remarkable Value). Archeological sites and traditional gathering areas used by American Indian groups exist in some meadows, and could be affected by the proliferation of social trails in meadows (cultural Outstandingly Remarkable Values). The extent of social trails in meadows may affect visitor experience, as meadows are enjoyable areas in which to engage in a variety of river-related related recreational opportunities—including nature study, photography, etc. (recreation Outstandingly Remarkable Value). Social trails may impact the scenic interface of river, rock, meadow, and forest; thus monitoring the number of social trails in meadows contributes to the protection and enhancement of the scenic Outstandingly Remarkable Value.

Measurement: The number of social trails emanating from selected roadside pull-outs.

Zones:
- 2A Open Space
- 2A+ Undeveloped Open Space

Standards: No net increase in number from 2004 baseline. No social trails for wetland features.

Sampling: Two field technicians sampled the number of social trails originating from selected roadside pull-outs in Zones 2A and 2A+ between 8/23/05 and 9/06/05. All sites monitored in 2004 field season were revisited, monitored for changes, and re-documented. Sampling locations are presented in Figure 6 below and include sites along Highway 140 (El Portal Road), Highway 41 (Wawona Road), and Yosemite Valley. Trailhead or origin locations along roads and in pull-outs were documented using photo points, GPS, and data forms.

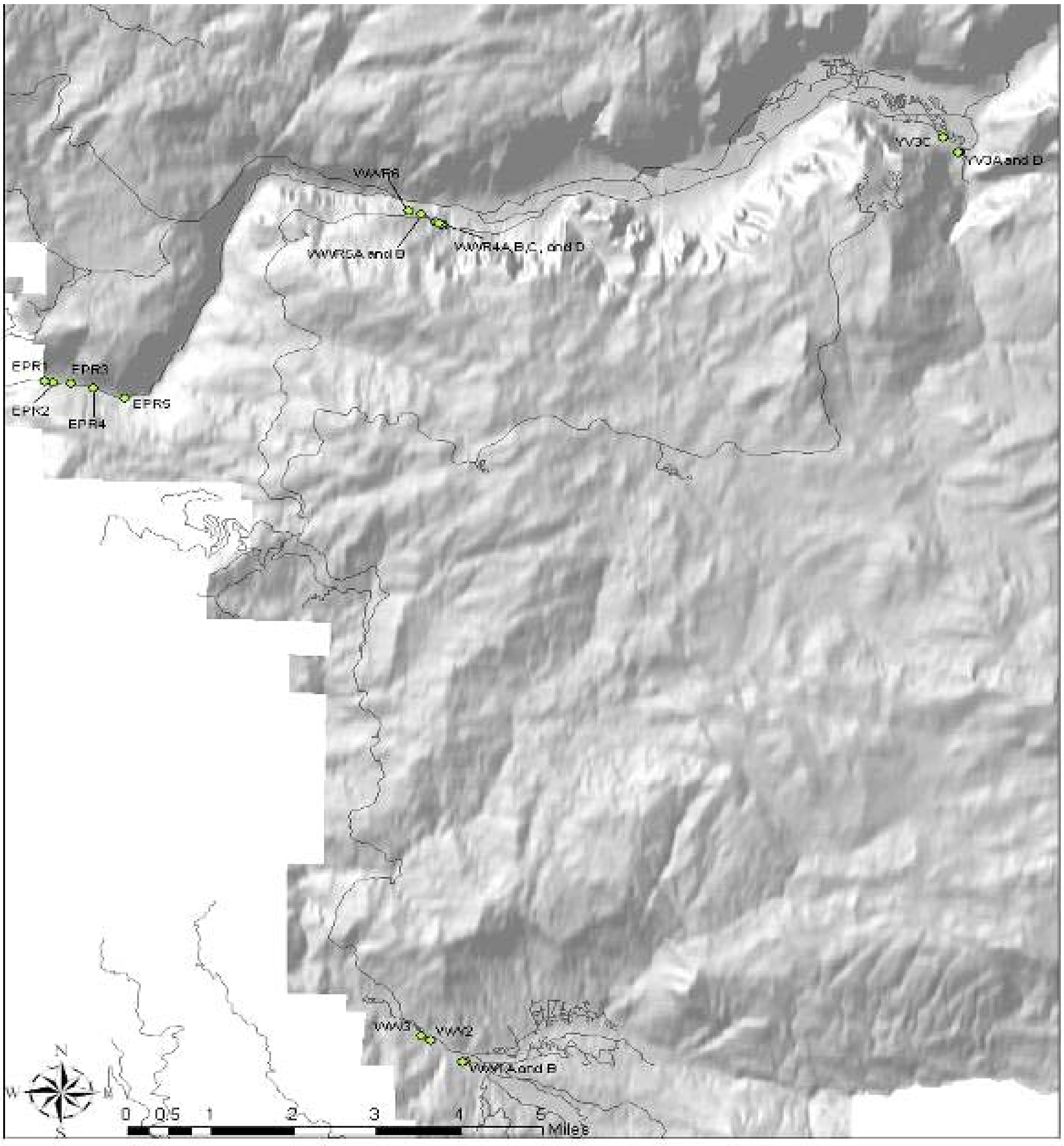


Figure 6. Number of social trails sampling locations.

Results: Table 5 provides a summary of monitoring results. A total of 32 social trailheads were documented at 18 different sites within Zones 2a and 2A+.

Table 5. Number of social trailheads at selected roadside pull-outs 2005.

Location	No. of Sites Assessed	No. of Social Trailheads
Wetland Features		
Bridalveil Meadow Unique Wetland (YV1)	See Map	See Map
Happy Isles Fen (YV3)	3	7
Wosky Pond (YV2)	See Map	See Map
Non-Wetland Features		
El Portal Road (ERP)	5	9
Wawona Area (WW)	4	5
Wawona Road (WWR)	6	11
Total	**18**	**32**

Figures 7 and 8 below present maps of the number and length of social trails emanating from roadside pull-outs and passing through wetland features in the Bridalveil and Wosky Pond meadows. In these figures the 1997 USGS wetland maps were overlain with the length of social trail data recorded in 2005 for the Length of Social Trails in Meadows indicator.

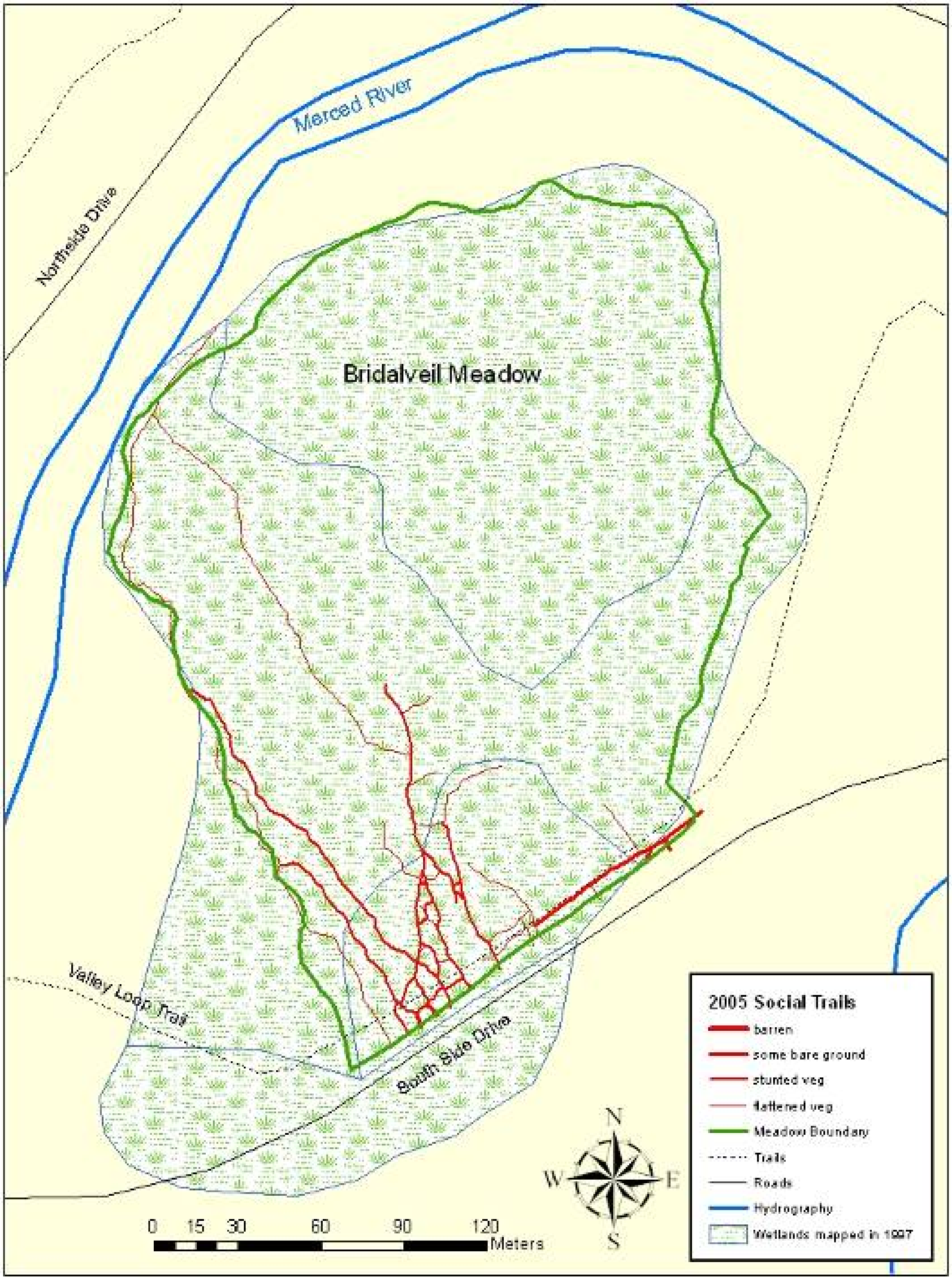


Figure 7. Map of social trailheads in Bridalveil wetland area.

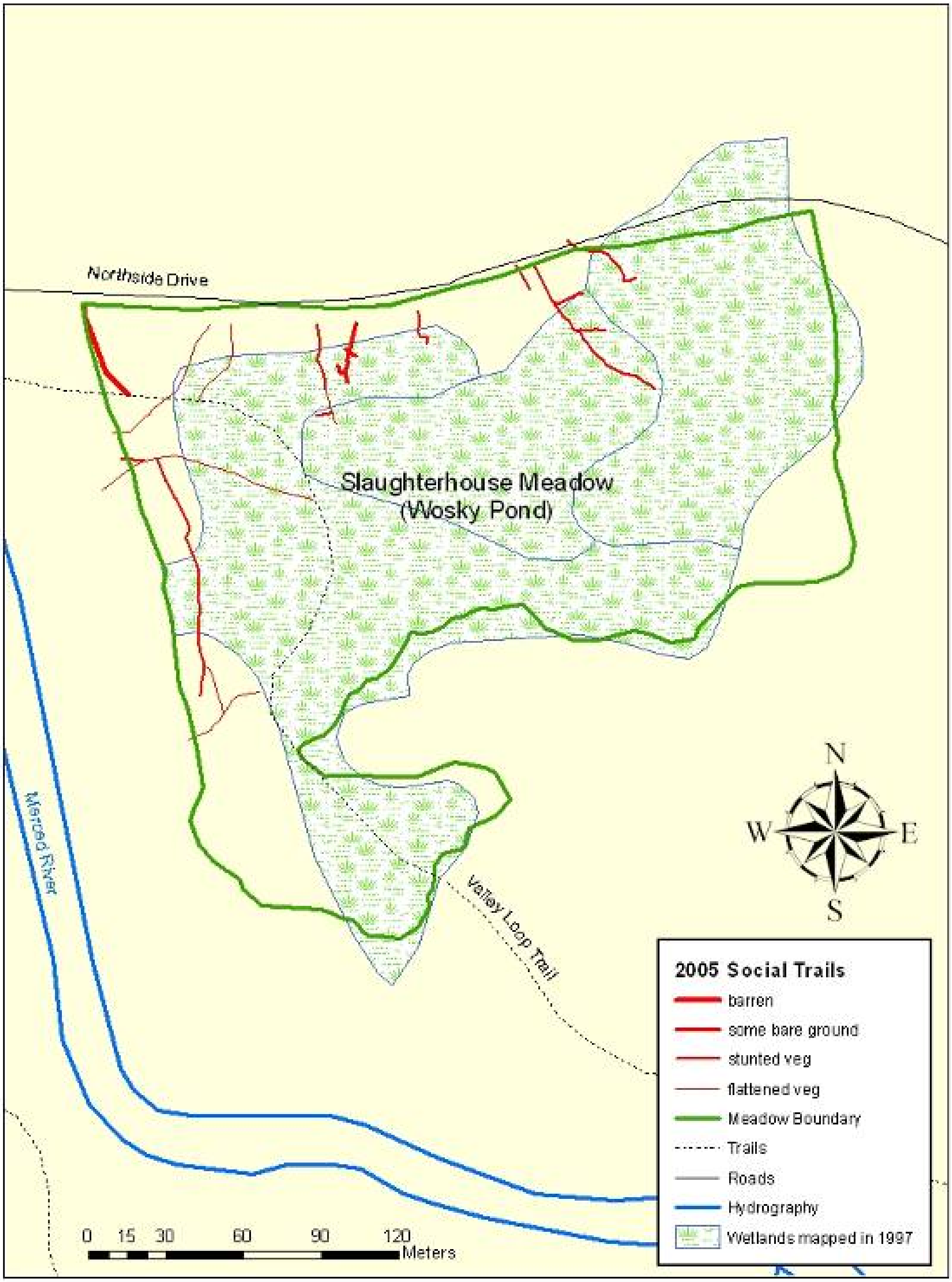


Figure 8. Map of social trailheads in Wosky Pond wetland.

Table 6 presents a comparison of the number of social trail monitoring results between 2004 and 2005. For wetland features, all sampling sites monitored in 2005 reported social trailheads present. An increase in the number of social trailheads was reported at Bridalveil Meadow and Wosky Pond based on more specific analysis using social trail mapping as presented in Figures 7 and 8 above. For non-wetland features, an increase in the number of social trailheads from 6 to 9 was documented at the El Portal Road sampling site, but there was an overall decrease from 36 to 32 (Table 6).

Table 6. Comparison of number of social trails 2004 – 2005.

Location	No. of Social Trailheads 2004	No. of Social Trailheads 2005
Wetland Features		
Bridalveil Meadow Unique Wetland (YV1)	3	See Figure 7
Happy Isles Fen (YV3)	7	7
Wosky Pond (YV2)	0	See Figure 8
Non-Wetland Features		
El Portal Road (EPR)	6	9
Wawona Area (WW)	5	5
Wawona Road (WWR)	15	11
Total	**36**	**32**

Discussion: Monitoring of the number of social trails in 2005 produced mixed results. For wetland features, trails were again documented at all three wetland areas sampled. For non-wetland areas one sample site saw an increase, another received the same number of trails and the third site saw a decrease in the number of social trails.

The continued presence of social trails in wetland features in 2005 presents some methodological concerns. Mapping data from the 2004 season indicates that social trails existed in Bridalveil and Wosky Pond meadows before the standard of “no social trails in wetland features” was established. This implies that the original standard was set at an unfeasibly low level of impact given existing conditions and that re-evaluation is necessary to achieve meaningful results. By their very nature, meadows are wet enough for a sufficient period in the growing season to prevent survival of tree species. In short, this means that wetland hydrology is directly responsible to a certain degree for proliferation of the meadow habitat (Mitsch and Gosselink 2000). Therefore, meadows in Yosemite Valley would be largely characterized by wetland features and, therefore, any social trails passing through the meadows would have a high likelihood of passing through wetland features as well.

Additionally, the fact that 2004 monitoring only addressed trailheads outside of, instead of trails within, the two wetlands, also makes comparison between 2004 and 2005 data for Wosky Pond and Bridalveil meadows difficult. The number of social trail data for Wosky Pond Meadow could be highly impacted by the utility construction occurring during the field season of 2005 that heavily impacted the road shoulder, graded areas, as well as access to the wetland feature. During monitoring activities it was noted that these construction activities, although limited to “in the road” or in the shoulder area made monitoring and collecting accurate data difficult. In addition, the number of social trail data for the Happy Isles fen is misleading because, upon scrutiny of trails in this area and discussions with Resources Management and Science Division staff, it was apparent that these trails were caused by official resource monitoring activities in the fen and were not caused by visitors.

Finally, the three additional trails found along the El Portal road sampling site appeared as though they could have been caused by wildlife. Therefore, there appeared to be no notable increase of social trails from 2004 to 2005 caused by human use.

2.3. LENGTH OF SOCIAL TRAILS

Meadows are delicate natural resources that contribute significantly to the ecology of Yosemite Valley. They also engender the Valley with a unique pastoral aspect conducive to the enjoyment of recreation and leisure activities. However, human use in meadows can cause adverse impacts including vegetation loss, introduction of exotic flora, soil compaction and loss, and other effects. Often these impacts are a result of social trail proliferation. As people walk out into the meadow to have a picnic or take in the views, they can leave behind an informal network of trails. These trails may negatively impact the integrity of the meadow ecosystem (Holmquist and Schmidt-Gengenbach 2003) as well as the quality of the visitor experience (Manning et al. 2005).

In 2004 an indicator was developed measuring the cumulative length of social trails in meadows. The length of social trails is indicative of the contiguity and ecological health of meadows and wetland areas - reflecting part of the biological Outstandingly Remarkable Values of the river corridor. It is also indicative of impacts to wildlife habitat, including special-status species (biological Outstandingly Remarkable Value). Archeological sites and traditional gathering areas used by American Indian groups exist in some meadows, and could be affected by the proliferation and length of social trails in meadows (cultural Outstandingly Remarkable Values). The extent of social trails in meadows may affect visitor experience, as meadows are enjoyable areas in which to engage in a variety of river-related recreational opportunities—including nature study, photography, etc. (recreation Outstandingly Remarkable Value). Social trails may impact the scenic interface of river, rock, meadow, and forest. In this manner, monitoring the length of social trails in meadows also contributes to the protection and enhancement of the scenic Outstandingly Remarkable Value of the river corridor.

Measurement: Total linear length in meters of non-formal or “social” trails in meadows.

Zones:
- 2B Discovery
- 2C Day Use

Standards: No net increase in length of social trails from 2004 baseline.

Sampling: Global Positioning System (GPS) units were used to map and measure the linear extent of social trails in the following meadows in Yosemite Valley: Bridalveil, El Capitan, Wosky Pond, Leidig, Sentinel, Cooks, Ahwahnee and Stoneman. Condition classes of trails were also recorded, ranging from “barely discernable” to “barren”, and disturbed areas were also noted.

Results: A complete series of maps representing linear extent of social trail monitoring in each meadow is on file with the VERP program coordinator in the Resources Management and Science Division. Figure 9 below represents an example of social trail mapping from El Capitan Meadow in 2005. Between 2004 and 2005 the linear extent of social trails increased in Cooks, El Capitan and Stoneman meadows (Table 7). While the Ahwahnee, Bridalveil, Leidig, Sentinel and Wosky Pond meadows saw decreases in total social trail length.

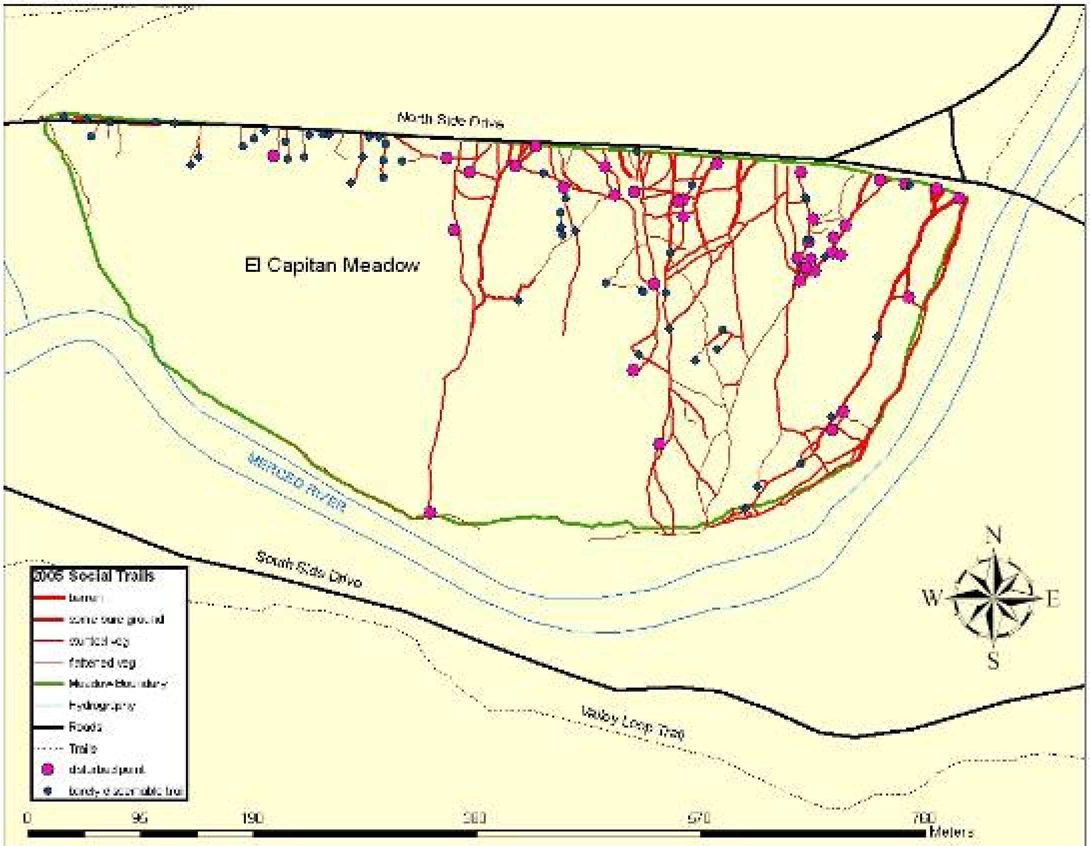
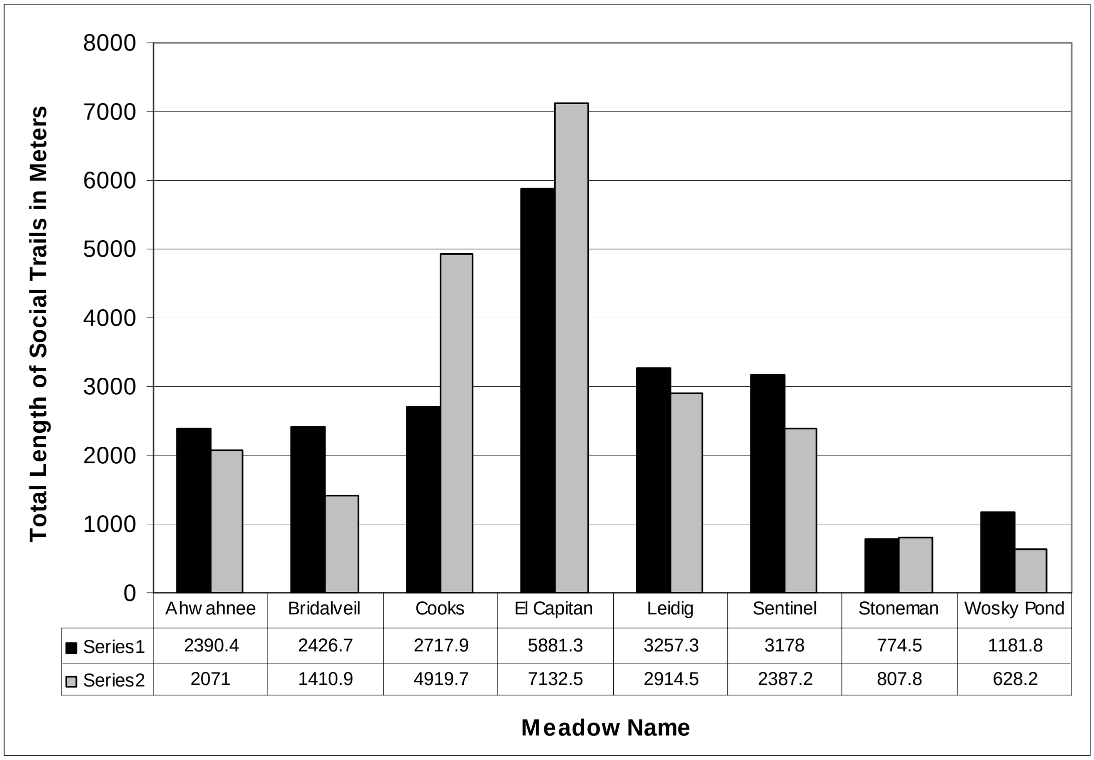


Figure 9. Map of social trails in El Capitan Meadow.

Figure 10 presents length of social trail monitoring results graphically. Overall, El Capitan meadow received the greatest linear extent of social trails in both 2004 and 2005, with more than one quarter of the total trail length for both years (5.9km for 2004, 7.1km for 2005). The graph also shows that Cooks meadow received the sharpest increase in social trail length increasing from a total of 2717.9 to 4919.7 meters. Stoneman and Wosky Pond meadows again had the fewest social trails, with 0.8km (3.6%) and (2.8%).

Table 7. Length of social trails in meadows 2004-2005.

Meadow	Total Social Trail Length (Meters)	
	2004	**2005**
Ahwahnee	2390.4	2071.0
Bridalveil	2426.7	1410.9
Cooks	2717.9	4919.7
El Capitan	5881.3	7132.5
Leidig	3257.3	2914.5
Sentinel	3178	2387.2
Stoneman	774.5	807.8
Wosky Pond	1181.8	628.2



	Ahwahnee	Bridalveil	Cooks	El Capitan	Leidig	Sentinel	Stoneman	Wosky Pond
Series1	2390.4	2426.7	2717.9	5881.3	3257.3	3178	774.5	1181.8
Series2	2071	1410.9	4919.7	7132.5	2914.5	2387.2	807.8	628.2

Figure 10. Comparison of length of social trails in meadows 2004 - 2005.

Discussion: Length of social trails monitoring in 2005 successfully documented existence of social trails in all eight meadows. Many of these social trails originated from roadways where visitors park their vehicles and access the meadows. In other instances, social trails originated from designated trails and structures such as the Valley Loop Trail and boardwalks.

The length of social trails was lower in 2005 than in 2004 in all of the meadows except for El Capitan, Cooks, and Stoneman meadows. These lower values in 2005 can possibly be explained by differences in timing of monitoring: in 2004, monitoring took place after the fall deer rut, and in 2005, care was taken to complete monitoring before the deer rut. Therefore, there were fewer deer-created trails, potentially influencing the overall decrease in total social trail length in most meadows. In addition, 2005 was characterized by higher amounts of rainfall. This allowed plants in the meadow to grow vigorously later into the season than in 2004, potentially making detection of trails with condition classes of low severity more difficult than in 2004, thereby decreasing the reported total length. Considering these points, it seems highly unlikely that the decrease is actually attributable to a decrease in visitor impact. These issues demonstrate that results for the monitoring of this indicator will vary from year to year due to factors other than human use. This suggests that yearly monitoring may be too frequent to capture changes due non-human related variables, and a more robust monitoring schedule should be developed that will decrease the effects of extraneous factors on data variability.

The increase in length of social trails found in Cooks and El Capitan meadows in 2005 may be attributed to a number of factors, including increase in visitor use and inconsistencies with monitoring in 2004 due to personnel limitations and vegetation monitoring conducted in Cooks meadow in 2005. This assumption is supported by the fact that some heavily used trails found and mapped in both Cooks and El Capitan meadow in 2005 were not mapped at all in 2004. These trails likely did not develop to this degree over the course of a single year. More likely, they were simply inadvertently omitted in the 2004 survey due to time constraints and personnel limitations. It stands to reason that these mistakes would occur in the meadows with the most social trails, because it is more difficult to keep track of mapped vs. unmapped trails in high density situations. Also, Cooks Meadow was a site for 2005 vegetation monitoring plots, and some trails were created during sampling conducted by Division of Resources Management and Sciences staff. This would explain the particularly sharp increase in social trails from 2004 to 2005 in Cooks Meadow. In the future, precautions should be taken so that social trail mapping precedes other monitoring activities, so as not to skew the results for this indicator.

The increase in social trails in Stoneman Meadow was very small and could have been caused by a heightened level of visitor use. However, this change is more likely a result of the yearly variability discussed above, and further monitoring will be needed to determine whether this year's increase was part of a trend or within the limits of yearly environmentally related variation.

After two years of monitoring with the same protocol, it is apparent that, although the methods are successful in depicting the extent of social trailing in the meadows, there needs to be a standardized means of comparing impacts between meadows. At this point, we are able to determine whether there is a quantitative increase in social trail length for any given meadow by simply comparing these values from year to year. However, total length is not a measure that can be used for a comparison between meadows of different sizes. To achieve cross-meadow and Park-wide comparisons, it would be necessary to convert length data to a density measure.

The collection of spatial data using GPS for this indicator provides a rich dataset for further examination and analyses of social trails with respect to their spatial extent and distribution related to other physical features. Figure 10 illustrates the utility of spatially displaying social trail data in addition to tabular and diagrammatic formats. In this example of El Capitan Meadow, most social trails were radiating from the road and lead to picturesque sites along the river or viewing areas in the meadow. Such information may inform management decisions if actions are necessary. The ecological significance of social trail proliferation can also be evaluated when social trail data layer is integrated with GIS layers of other park resources such as wetland features, habitats of rare or threatened species, and cultural resources. Also, the utility of geospatial technologies in monitoring social trails was also quite effective for the communication of monitoring results. The data collected from 2004 and 2005 will inform sampling design and help prioritize monitoring efforts for future monitoring when a complete inventory of social trails may not be feasible or necessary. The spatial patterns of social trails also enables analyses that would shed light on potential causes of the problem and lead to informed management actions, especially when other resource data layers are integrated into this dataset.

2.4. WILDLIFE EXPOSURE TO HUMAN FOOD

The Merced River corridor provides habitat for a variety of animal species. Myriad insects, birds, amphibians and mammals depend on the river and its surroundings for survival. This wildlife is part of the Merced River's biological Outstandingly Remarkable Values. However, studies have shown that human use may have an adverse impact on wildlife (Decker et al. 1992, Manfredo et al. 1995). Impacts include loss of habitat and food, predation, and others.

Of particular concern in many national park units is the feeding of wildlife. In Yosemite Valley human-bear interactions have been of concern. The Black Bear (*ursus americanus*) is quite common in the park and human interaction with them is frequent. These interactions, however, have not always been positive. Often visitors will make their food available to bears by leaving it un-attended at their campsite or in their car. There are documented instances of bears breaking into visitors' vehicles or rummaging through their camp to obtain this food. Bears can habituate easily to human food and are intelligent enough to pursue this food source to the detriment of both the animal and the visitor. A bear's ability to successfully survive in the wild is diminished when it becomes habituated to human food. And bear "break-ins" to visitors' vehicles and campsites can cause significant impacts to personal property and the quality of a visitors' experience.

Therefore, an indicator was developed in 2004 to measure visitor compliance with food storage regulations. Compliance rates provide meaningful information as to the extent to which human food may be available to bears. This is indicative of the extent to which human use in the Merced River corridor is causing negative impacts to bear populations.

Measurement: Percent compliance with food storage regulations at selected sights.

Zones:
- 2C Day Use
- 2D Attraction
- 3A Camping
- 3B Visitor Base and Lodging

Standards: 95% or greater compliance with food storage regulations in selected campgrounds and parking areas.

Sampling: The monitoring data for this indicator was collected and incorporated into the Bear Patrol Log Database (BPLD). The BPLD was developed for the Human-Bear Management Program (HBMP) in 2005 to ensure accountability with HBMP-funded employees and to collect data on bear monitoring and management activities in the field. In Yosemite Valley, there are an average of 15 HBMP-funded employees that spend at least 80% of their time on bear related issues between the months of May and October. These employees include Protection, Campground and Interpretation Rangers, and Wildlife Technicians. While the primary duties differ among work units, all employees share the common goal of mitigating human-bear conflicts and protecting wildlife from exposure to human food. This is accomplished through proactive patrols between the hours of 5 p.m. and 4 a.m. when bear activity is the greatest. During patrols, visitors are educated about proper food storage through one-on-one interpretive contacts, campsites and vehicles are checked for food storage compliance, and food storage regulations are enforced through verbal or written warnings and citations.

Non-compliance includes the following violations:

1. Feeding human food to wildlife – Knowingly offering human food or baiting wildlife.
2. Improper food storage – Human food stored in locations that are considered inappropriate, such as inside vehicles after dark or in containers that are not approved by the park as wildlife resistant;
3. Improper use of food locker – Food is put in food locker but the locker is wide open, unlocked, or not latched in a way consistent with the instructions provided and the visitors are either away from their site or asleep.
4. Leaving food unattended – Food left in open locker, out in campsite, or other location where the food is out of arms reach, is not actively being prepared or eaten, and/or the food is not visible to any of the camp occupants.

Campground inspections to determine compliance rates were generally conducted after 10 p.m. when most visitors were finished eating dinner and food was put away. Inspections conducted earlier than 10 p.m. often resulted in a very low compliance rate because most people preparing dinner had their food lockers open and food items out of arms reach. These incidents were documented in the BPLD as educational contacts rather than violation or inspection records.

Parking lot inspections were conducted throughout the night, but because food stored inside vehicles during daylight hours is legal, compliance checks on vehicles could only be performed after dark.

Average compliance rates were determined by inspecting either a certain number of campsites or vehicles. The number of food storage violations was also documented, but not necessarily as part of an inspection. On many occasions, especially when responding directly to bear activity, food storage violations were found, corrected and documented, but were not calculated in the average compliance rate for an area because they were not part of an inspection. In the BPLD, food storage violation records can either stand alone or be part of an inspection record.

Figure 11. Campsite bear control food storage locker.

Results: Compliance rates with food storage regulations at selected sites are presented below. Results are organized by location (Table 8). Graphs present monthly compliance rates at each sample location (Figures 12-19).

Table 8. Food Storage Inspections in Yosemite Valley.

Location	Inspection Type	Number Inspected in 2005	Average Compliance Rate
Yosemite Lodge	Vehicles	13120	95.40%
Camp 4	Vehicles	9958	95.12%
Ahwahnee	Vehicles	3702	94.17%
Curry Orchard Lot	Vehicles	2348	94.21%
Curry Village	Vehicles	4562	93.14%
Upper Pines	Campsites	2580	97.91%
Camp 4	Campsites	471	91.93%
Housekeeping Camp	Campsites	9406	91.63%

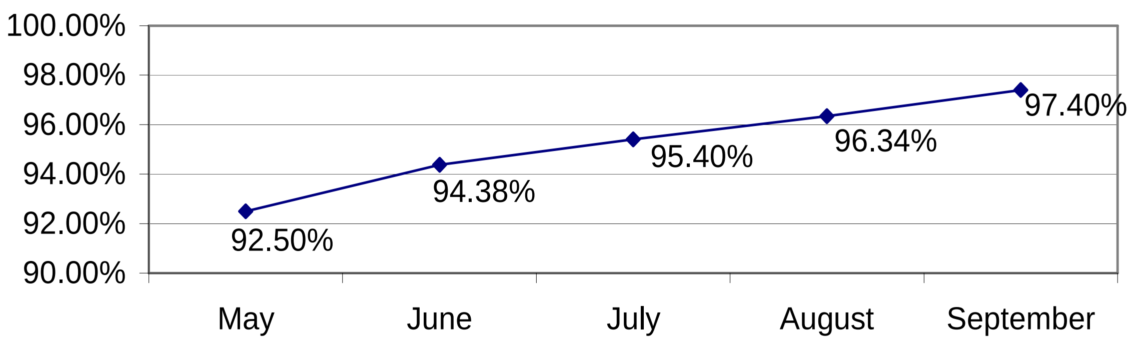


Figure 12. Compliance rates at Yosemite Lodge (vehicles).

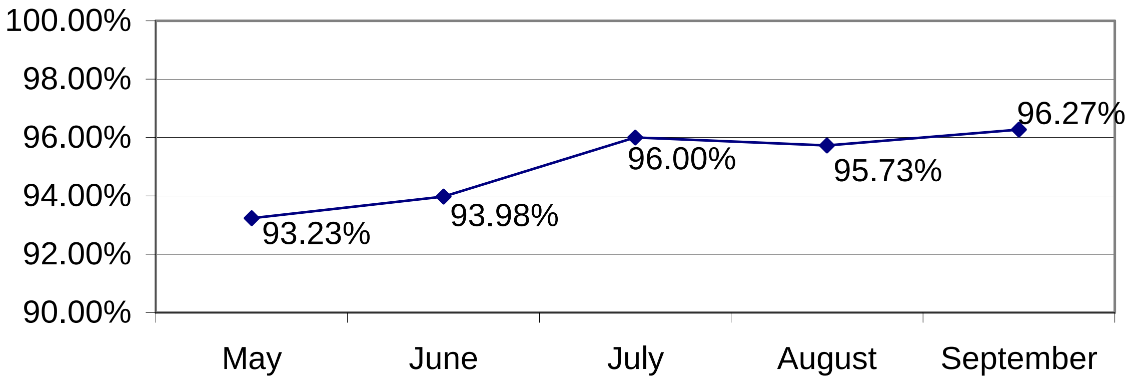


Figure 13. Compliance Rates at Camp 4 (Vehicles).

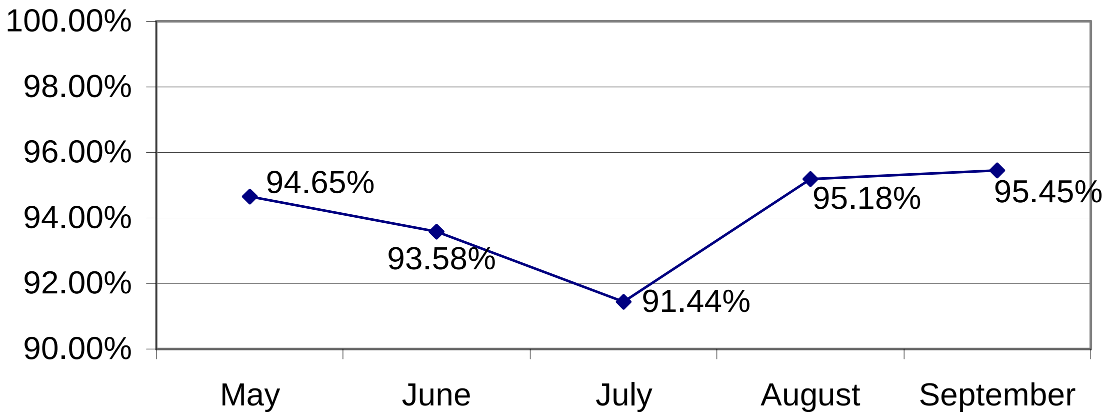


Figure 14. Compliance Rates at Ahwahnee (Vehicles).

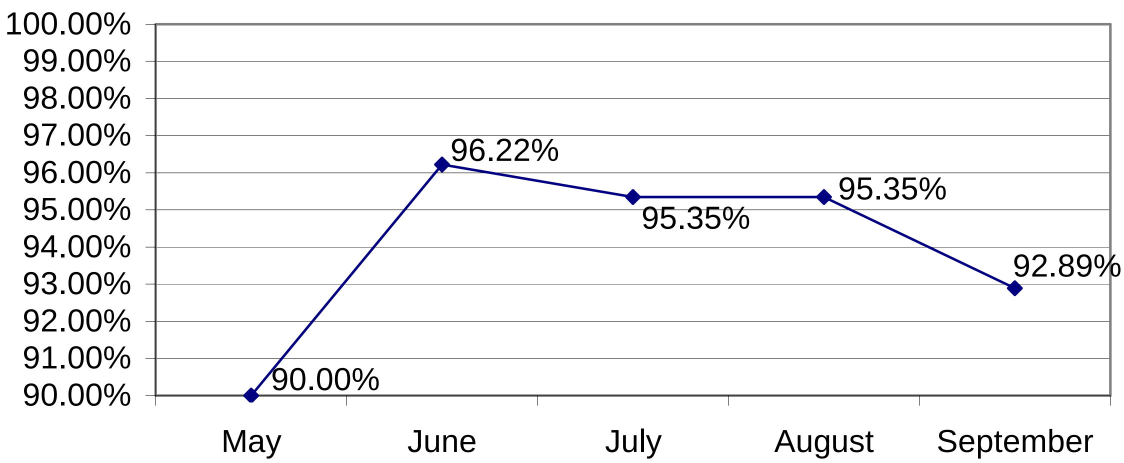


Figure 15. Compliance rates at Curry Orchard Lot (Vehicles).

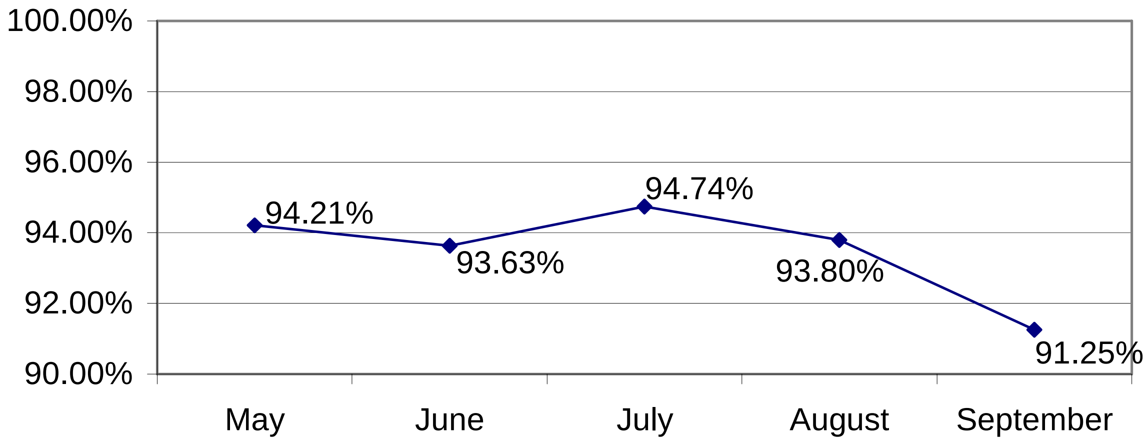


Figure 16. Compliance rates at Curry Village (vehicles).

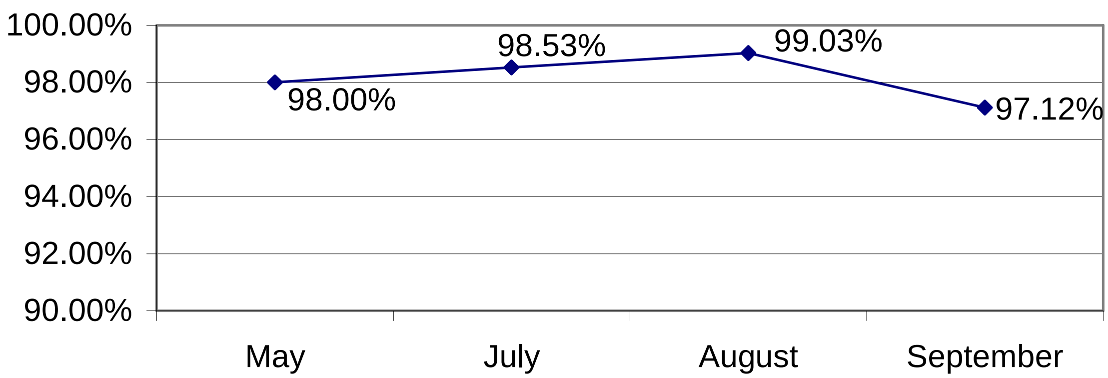


Figure 17. Compliance rates at Upper Pines (campsites).

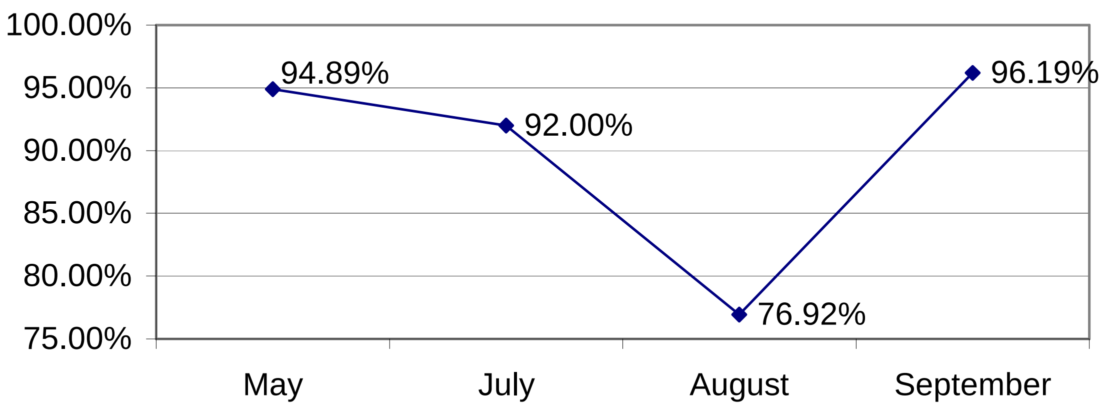


Figure 18. Compliance rates at Camp 4 (campsites).

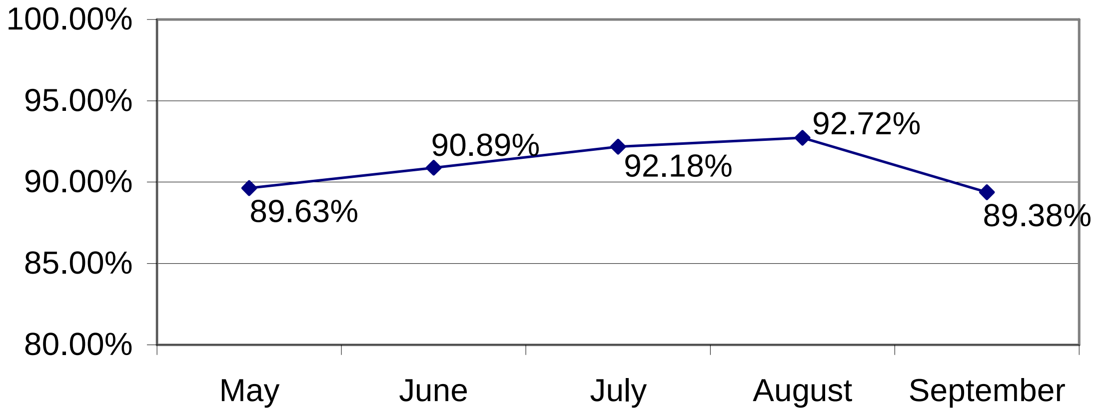


Figure 19. Compliance rates at Housekeeping Camp (campsites).

Discussion: Monitoring of this indicator in 2005 suggests that compliance rates are below standard at several parking and overnight facilities in Yosemite Valley. Of the eight locations inspected in 2005, only three met the standard of 95% or greater compliance with food storage regulations. Two parking areas, Yosemite Lodge and Camp 4 had a 95% compliance rate, and Upper Pines Campground had a 97% compliance rate. Although these areas met the standard, there were still over 1800 food storage violations found in these three areas between May and October.

The five locations that did not meet the standard included three parking areas and two campgrounds. Housekeeping Camp and Camp 4 Campground had the lowest compliance rates at 91%. Over 2600 food storage violations were documented in the two campgrounds. Violations included open or improperly secured food lockers, visitors too far from food, and food left unattended in campsites.

The total number of food storage violations found in all eight locations inspected in 2005 exceeded 5200 between May and October. Extrapolating from these numbers and estimating 180 days of data collection, bears had access to human food in the Valley on 28 different occasions each day. However, this does not reflect the number of overflowing trashcans or unsecured dumpsters, trashcans, and recycling containers; it also does not include the other campgrounds or parking areas throughout the Valley.

Monitoring in 2005 produced some methodological concerns as well. Due to the sporadic nature of ranger inspections, a strict sampling schedule was not followed. Therefore, though data represent a random sample of food storage compliance, caution should be taken when extrapolating to a larger population. Nevertheless, results are suggestive of food storage compliance rates for the specific sampling locations and periods monitored. Additional analysis may be conducted to test the extent to which these sampling concerns may have affected results. Due to the relatively large sample size of this data, further analysis may be conducted to test the reliability and validity of the data by selecting a random sample from the data set. Multiple random samples may be selected and tested for variance.

2.5. RIVERBANK EROSION

Riverbank erosion has been selected as an indicator because soils and the vegetation that stabilizes them are integral to the stability and integrity of riparian ecosystems. Although soil erosion occurs along the river as a result of natural river processes, such erosion can be accelerated and exacerbated by visitor use (Figure 20). Increasing visitor use on susceptible substrate soils often results in increased soil erosion, so this indicator is valuable for assessing a site's ability to sustain varying amounts of visitor use.

Riverside soils and vegetation regulate the entry of groundwater, surface runoff, nutrients, sediments and other particulates, and fine and course organic matter to rivers and streams, thus affecting water quality. Accelerated erosion associated with trampling and river access can alter these processes, leading to changes in hydrology and water quality. It also can initiate formation of gullies and headcuts, which can lower water tables and change drainage patterns through meadows, resulting in the “drying out” of the meadow.

In addition to indicating loss of soil, measuring the amount of riverbank erosion associated with visitor use will be used as an indicator of changes that may be occurring to cultural Outstandingly Remarkable Values within the segment—namely to archeological sites (if archeological sites occur within erosion monitoring sites). Soil erosion along river banks that occurs at archeological sites would suggest a potential loss of site stability. This loss of soil stability would then indicate loss of intact archeological artifacts and features, critical components of archeological site integrity. Once artifacts and features are displaced from their original context or lost, the information inherent to those deposits is also lost.

Figure 20. Human use and riverbank erosion along the Merced River.

Measurement: Riverbank erosion was assessed using two metrics: (1) vegetation condition rating and (2) erosion condition rating. Ratings for each metric were based on Likert scale and varied from 1 to 4, with lower condition ratings indicating a lower level of vegetation impact and erosion, and higher condition ratings indicating a higher level of vegetation impact and erosion. Other attributes that contribute to the degree of riverbank erosion were also recorded, including type/slope of riverbank, substrate type, type of visitor access.

Zones:

- 2B Discovery
- 2C Day Use

Standards: The data collected in 2005 will serve as an inventory and baseline dataset for future monitoring efforts.

Sampling: An inventory of riverbank erosion condition along the Merced River through Yosemite Valley was conducted. Monitoring staff conducted assessments along both banks of the river from Pohono Bridge in the West Valley to the Happy Isles Gauging Station in the East Valley. A total of 10 river miles were surveyed for the measurements described above. Monitoring was conducted in 100m increments with an assessment resolution level of 10m (i.e. an erosion condition class and a vegetation condition class were assigned to every 10m segment) riverbank erosion condition (Figure 21). Three Likert-type scales were used to determine 1) the riverbank type, 2) the vegetation condition, and 3) the erosion condition.

The monitoring protocol called for the use of Global Positioning System (GPS) units to map erosion conditions along the river. However, due to the dramatic topography of the Valley it was difficult to obtain a sufficient satellite signal for the GPS units to function properly. Consequently, mapping was conducted manually using printed maps.

Results: A Riverbank Condition Index (RCI) was developed to integrate erosion and vegetation condition information into a single composite index to facilitate communication and mapping. A heavier weight is put on the erosion condition due to its higher ecological significance. The range of RCI index values is from 1 to 10. Higher index values would indicate more severe riverbank erosion conditions.

$$RCI = \frac{\sum(ER_i \times E_i\%) + \sum(VR_i \times V_i\%)}{2}$$

Notations:
RCI = Riverbank Condition Index
ER_i = Erosion Condition Class *i* (*i* = 1 to 4)
$E_i\%$ = % segment assigned to Erosion Condition Class *i* (values range from 0 to 1, or 100%)
VR_i = Vegetation Condition Class *i* (*i* = 1 to 4)
$V_i\%$ = % segment assigned to vegetation condition class *i* (values range from 0 to 1, or 100%)

The following graph presents the indexed riverbank erosion condition REC Index value for each 100m segment along both the right and left banks (as one looks downstream) of the Merced River through Yosemite Valley.

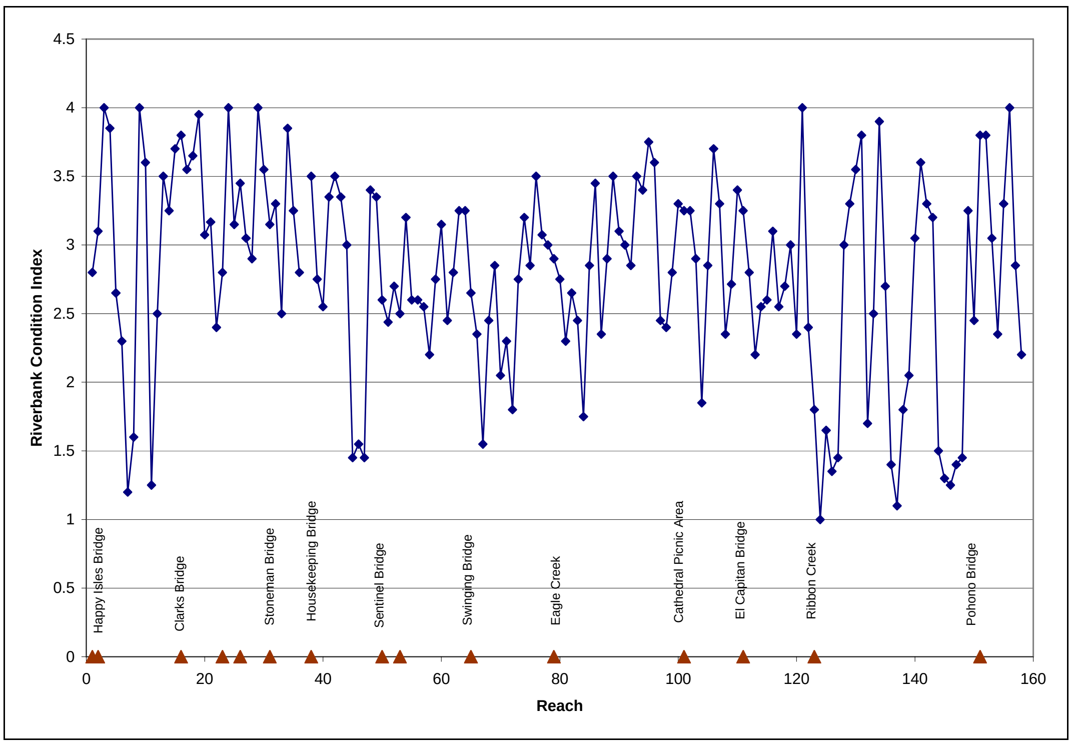


Figure 21. Riverbank Condition Index Assessment along the Right Bank of the Merced River from Happy Isles gauging station to Cascades Dam significant landmarks are indicated at their respective location with regard to the various segments along the river along the x-axis with the Riverbank Erosion Index along the y-axis.

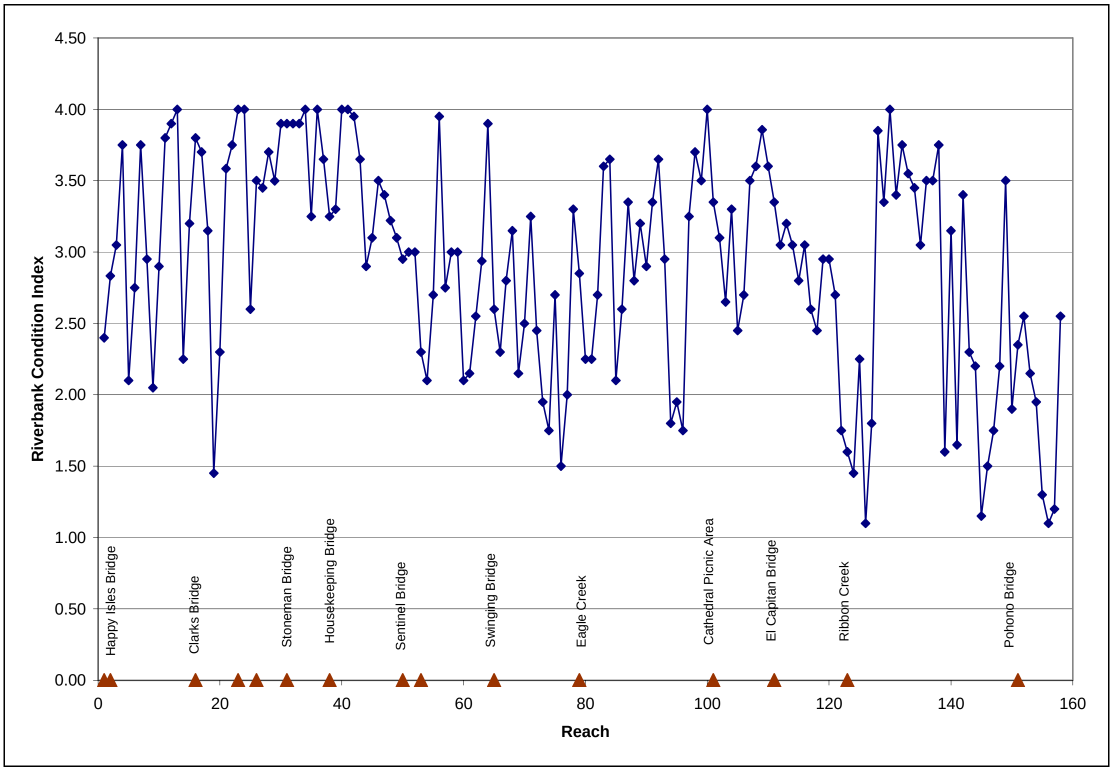


Figure 22. Riverbank Condition Index Assessment along the Left Bank of the Merced River from Happy Isles gauging station to Cascades Dam significant landmarks are indicated at their respective location with regard to the various segments along the river along the x-axis with the Riverbank Erosion Index along the y-axis.

Discussion: Data collection efforts in 2005 provided an inventory of riverbank erosion condition for both banks of the Merced River from Happy Isles Dam to Pohono Bridge (Figures 21 and 22). The data show that there is high variability in riverbank erosion condition along the Merced River in Yosemite Valley, and that there is no distinct east to west trend of riverbank condition. It is clear from the data, however, that areas with high levels of visitor use tend to exhibit high RCIs (levels of riverbank erosion), such as at Stoneman Bridge (raft put-in), Housekeeping, Swinging Bridge, and Cathedral Picnic Area.

Visitor use categories did not seem to correlate as highly with RCI as did the degree of visitor use as represented by the proximity of river segments to park infrastructure (roads, trails, campgrounds, etc.). A map depicting this relationship was created by Resources Management and Sciences staff through a GIS analysis involving a geographical overlay of inventory results (RCI values associated with each 100m segment of riverbank) and visitor access features (roads, campgrounds, trails, etc.) and High Use Zones identified by a pilot survey in 2004.

Given the highly erratic nature of the data from upstream to downstream, it is evident that there is no distinct east to west trend of riverbank condition: the riverbanks of the Merced on one end of Yosemite Valley are not exhibiting notably higher impacts than those on the other end. However, there is great variation in riverbank condition throughout the Valley and over short distances, which is also illustrated by the erratic dataset. The following example demonstrates the relationships that will be revealed through the GIS analysis: for example, the left riverbank segment just downstream of Eagle Creek where the Valley View pullout is located and the Green Dragon stops for visitors to get out and take pictures exhibited a Riverbank Erosion Index of 4, the highest value, indicating high levels of impact and erosion. In contrast, just 200m downstream of this segment in an area not as accessible to visitors (low proximity to infrastructure), the left riverbank exhibited an RCI of just over two, indicating a relatively low level of impact and erosion conditions. Such an example illustrates that riverbank condition varies greatly depending on level of access, and these impacts tend to be localized and highly dependent on the degree of visitor impact. RCI values also responded to changes in natural erosion along the river, which further necessitates the need for an infrastructure overlay to determine where erosion condition problems are visitor related and where they are related to natural fluvial geomorphologic processes.

Data collection efforts in 2005 focused on inventorying riverbank erosion condition and refining the monitoring protocol. By its nature, an inventory is an intensive activity requiring significant commitments of time and resources. Subsequent monitoring activities should, therefore, focus on selected segments of the river. The 2005 inventory will provide a baseline from which to select appropriate sampling sites for continued monitoring. An inventory should be conducted on a 3 to 5 year interval in order to capture significant changes in riverbank condition, and annual monitoring of selected sights will be conducted in the interim.

2.6. ETHNOBOTANY

Ethnobotany is considered to encompass all studies which concern the mutual relationship between plants and traditional peoples (Cotton 1996). Plants have been used by native peoples for thousands of years for medicine, food, shelter, textiles, tools, and many other purposes (Ruppert 2001). Traditional plant gathering by indigenous populations is increasingly being recognized as an integral part of the cultural and natural significance of protected areas (Cotton 1996; Balick 1996; Pieroni 2006).

The Merced River corridor has many culturally Outstandingly Remarkable Values including historic structures, archeological sites, and significant American Indian presence. Both historically and contemporarily, the Miwuk Indians have played a significant role in the Merced River ecosystem. Through their traditional management of plant communities, they have helped to shape the landscape of the river corridor as we know it today. Their heritage can be found in archaeological caches and still today in their continued traditional practices. A new integrated indicator was formulated this year to address this latter cultural significance of the river corridor.

The Miwuk Indians have traditionally gathered a variety of flora found in the Merced River corridor. These gathered objects are used in traditional basketry, for medicinal purposes, for food, and in play. The continuation of these traditional gathering practices and preservation of plant populations utilized by the Miwuk Indians is essential for the preservation of this outstanding cultural resource in the Merced River corridor.

Measurement: The health, condition and usability of four traditionally gathered plant species:

1) Bracken Fern (*Pteridim aquilinum*)
2) Blue Elderberry (*Sambucus mexicana*)
3) Showy Milkweed (*Asclepias speciosa*)
4) Redbud (*Cercis occidentalis*)

Zones:

- 2B Discovery
- 2C Day Use

Standards: 2005 was a pilot year for this indicator and no standards have been set as of yet. Data collection efforts this year will provide baseline data from which to formulate appropriate standards.

Sampling: Two techniques were employed for monitoring ethno-botanical resources in Yosemite Valley: 1) a scientific assessment, and 2) a practitioner assessment. Both are described below.

(A) Scientific Assessment: Standard plant population parameter sampling procedures were employed to assess the condition of target species (Elzinga, et al. 1998). Monitoring locations within the corridor were chosen based on traditional practitioner use, proximity to high use areas, and ease of stand delineation. Site locations must remain anonymous under confidentiality clauses in the National Historic Preservation Act, the Native American Graves Protection and Repatriation Act, and the American Indian Religious Freedom Act, which protect traditional plant resources. Methods for sampling varied among species, which was necessitated by differences in growth habits and morphology. Bracken fern and showy milkweed populations were sampled using 25m² plots, and representative blue elderberry and redbud individuals were selected and monitored. Raw stand data for "number of individuals" and "number of damaged individuals" were converted to the more meaningful and comparable parameters of "stand density" and "percentage of damaged individuals", respectively, for reporting purposes. The table below summarizes the parameters measured for each species.

Table 9. Plant population parameters measured during scientific assessment of traditional plant resources.

Species	Parameters	Measurement Unit
Showy Milkweed	1. Number of individuals (per plot)	Number
	2. Number of damaged individuals (per plot)	Number
	3. Distance to nearest social trail (per plot)	Meters (to 0.1m)
	4. Presence of non-native species within 10m (per plot)	Presence/absence, species (if present)
	5. Height (per individual)	Centimeter
	6. Stem diameter (per individual)	Millimeter
	7. Life stage (per individual)	Vegetative (V) Flowering (Fl) Fruiting (Fr)
Bracken Fern	1. Number of individuals (per plot)	Number
	2. Number of damaged individuals (per plot)	Number
	3. Distance to nearest social trail (per plot)	Meters (to 0.1m)
	4. Presence of non-native species within 10m (per plot)	Presence/absence, species (if present)
	5. Height (per individual)	Centimeter
	6. Stem diameter (per individual)	Millimeter
	7. Life stage (per individual)	Fiddlehead (F) Immature (I) Mature (M)
Blue Elderberry	1. Height	Meters (to 0.01m)
	2. Breadth of crown	Meters (to 0.01m)
	5. Non-native species within 10m	Presence/absence, species (if present)
Redbud	1. Height	Meters (to 0.01m)
	2. Breadth of crown	Meters (to 0.01m)
	4. Non-native species within 10m	Presence/absence, species (if present)

Figure 23. Photo taken during scientific assessment of traditional plant resources.

Practitioner Assessment: Practitioners conducted field assessments on 11/5/05. They monitored three blue elderberry individuals and three redbud individuals for usability in a variety of contexts. Overall usability assessments (for particular usages in the case of blue elderberry) ranged from "0" to "10", with "0" indicating no usability, "1" indicating extremely poor usability, "10" indicating optimal usability, and intermediate numbers reflecting a gradient of usability within those parameters. "Number of usable stems" and "Number of broken usable stems" results shown below have been translated in numeric usability classes. Original data translation into classes is as follows:

Table 10. Usability classes for "number of usable stems" and "number of broken usable stems", from practitioner assessment of traditional plant resources.

Original practitioner count	Usability class
1-10	1
11-20	2
21-30	3
31-40	4
41-50	5
51-60	6
61-70	7
71-80	8
81-90	9
91-100+	10

Results: Results from 2005 ethnobotany monitoring are presented below.

(A) Scientific Assessment: Stand parameter data for bracken fern and showy milkweed, as well as individual parameter data for blue elderberry and redbud are shown in Tables 15-18. Sample individual data for bracken fern and milkweed are also presented in Tables 11-14.

Table 11. Stand parameter data for bracken fern.

Stand Parameters				
Plot	Density (plants/m²)	% of damaged individuals	distance to nearest social trail (m)	Presence of non-native species within 10m
BF1	9.16	3.1	3.5	no
BF2	7.80	1.0	19	yes
BF3	4.04	2.0	4	yes
BF4	19.00	4.2	3	yes

Table 12. Individual parameter data for bracken fern.

Individual Parameters					
Plot	Rep. Individual	Height (cm)	Stem Diameter (mm)	Life stage (I=immature, M=mature)	General Health
BF1	1	76	5	M	ok
BF2	10	77	6	M	slight necrosis
BF3	18	81	8	M	ok, damaged
BF4	9	55	3	M	slight rust, damaged

Table 13. Stand parameter data for showy milkweed.

Stand Parameters				
Plot	Density (plants/m²)	% of damaged individuals	distance to nearest social trail (m)	Presence of non-native species within 10m
MW1	8.84	0.9	6.5	yes
MW2	9.68	0.4	39	yes
MW3	4.52	0.9	0	yes
MW4	1.2	0	5	yes

Table 14. Individual parameter data for showy milkweed.

Individual Parameters					
Plot	Rep. Individual	Height (cm)	Stem Diameter (mm)	Life stage (V=vegetative, Fl=flowering, Fr=fruiting)	general health
MW1	1	35	3	V	ok
MW2	2	131	15	Fr	ok, slight chlorosis and necrosis
MW3	2	38	4	V	ok, some hervibory
MW4	4	68	7	V	slight necrotic mottling

Table 15. Individual parameter data for blue elderberry.

Representative Individual	Height (m, to 0.01m)	Breadth of Crown (m, to 0.1m, avg. of widest and narrowest sections)	Presence of non-native species within 10m
1	5.76	8.95	yes
2	4.21	5.72	yes
3	4.33	6.7	yes

Table 16. Individual parameter data for redbud.

Individual	Height (m, to 0.01m)	Breadth of Crown (m, to 0.1m, avg. of widest and narrowest sections)	Presence of non-native species within 10m
1	5.09	9.13	yes
2	0.98	1.15	yes
3	8.26	8.68	yes

(B) Practitioner Assessment: The following tables present results from the practitioner assessments.

Table 17. Usability Assessment for Redbud Individuals.

Redbud Individual	Usable stems (class)	Broken usable stems (class)	Overall usability assessment (0-10)
1	1	0	1
2	0	0	1
3	10	1	7

Table 18. Usability Assessment for Elderberry Individuals.

Elderberry individual	Traditional Use	Usable stems/ berry bunches (class)	Broken usable stems/ berry bunches (class)	Overall usability assessment (0-10)
1	Clappers	1	0	4
	Staves	1	0	3
	Flutes	3	0	3
	Fire Drill	1	0	8
	Food	2	0	3
2	Clappers	2	0	6
	Staves	0	0	0
	Flutes	0	0	0
	Fire Drill	1	1	7
	Food	3	1	4
3	Clappers	1	0	4
	Staves	3	0	6
	Flutes	3	0	4
	Fire Drill	2	0	4
	Food	No data taken	No data taken	4

Discussion: As mentioned before, 2005 was the pilot season for this indicator. A significant amount of time and energy was invested in developing a solid foundation for monitoring with a few representative traditionally used plant species and populations in Yosemite Valley. The integrated nature of this indicator allowed for the cooperation of manyDivisions within the park and the local American Indian community. We established a working dialog with the Southern Miwuk Tribe, and met regularly to discuss species and site selection, monitoring issues and concerns, and data collection.

Plant species populations sampled (bracken fern and showy milkweed) varied greatly in both stand and individual parameters. Stand parameter differences can most likely be attributed to variation in environmental conditions between plots (e.g. nutrient and water availability will affect density of plants) and degree of human impact. Individual parameter differences are caused by a combination of age stratification and natural variation within the population, with other factors, such as selective herbivory and disease, also likely being influential.

Variation in bracken fern stands and individuals appeared to be related to the aforementioned factors, but original conjectures regarding the method for determining life-stage using petiole length in bracken fern proved to be misleading given the wide range of height values collected from observably mature plants. It appeared that this height variation could be better attributed to light, water, and nutrient availability than simply to age.

Showy milkweed plots 3 and 4 were located near the riverbank in areas with sandy, nutrient-poor soils, which may explain the low plant densities compared with the first two milkweed plots (Table 13). We observed a variety of life-stages in both plant populations, which indicates multi-generationality in bracken fern, a population characteristic important to American Indians, and variation in flowering and fruiting times in showy milkweed, which may increase seed survival and recruitment of seedlings. In some cases, plots located near social trails exhibited higher numbers of damaged individuals and lower plant densities (Table 14). Since the objective of sampling was to monitor human impacts on traditional plant resources, plots in relatively close proximity to social trails and other access points were selected intentionally. Also important, however, was that stands of differing plant densities and proximities to social trails were chosen to achieve a representative sample that would capture variation in the species populations.

Individual plants sampled (blue elderberry and redbud) also exhibited a great degree of variation, most likely attributable to the factors already discussed (Tables 15 and 16). Practitioner assessments of these species showed that, at least at this time, most individuals sampled exhibited 30 or less usable stems and an overall usability of moderate to poor (Table 17). This is excluding, however, one redbud individual that was observed to be optimal for use, and a blue elderberry individual that was observed to have a relatively high usability for Fire Drills (Table 17). Broken stems and damage appeared to be a minor issue only with one redbud individual and one blue elderberry individual (Table 18).

2.7. WILDERNESS ENCOUNTERS

One of the components of the recreational Outstanding Remarkable Value for the Merced River Plan is the opportunity for solitude. Solitude has been an enduring characteristic of a Wilderness experience (Lucas 1964). The Wilderness Act of 1964 stipulates that areas designated as such provide outstanding opportunities for the enjoyment of solitude. The un-trailed zone (1A) trailed (1B) Wilderness zones of the Merced River should provide a high opportunity for solitude.

Expectations for solitude and actual numbers and types of groups encountered have been shown to have a significant effect on the quality of visitor experiences (Patterson and Hammitt 1990, Vaske et al. 1986, West 1982, Newman 2002). Encounters are also an excellent way to assess use levels and density, which can affect other Outstandingly Remarkable Values such as the biological, cultural, and scientific values set for the river corridor. For example, higher levels of use may result in compromised water quality.

Measurement: The number of encounters with other hiking parties on and off trails in Wilderness.

Zones:
- 1A Un-trailed
- 1B Trailed Travel

Standards: For un-trailed zones no more than one encounter with another party per four hour period 80% of the time. For trailed zones no more than one encounter with another party per hour 80% of the time.

Sampling: Encounters were recorded by a National Park Service Ranger hiking along trails and off-trails in the backcountry. These were done as part of the Rangers routine patrol of the backcountry. Encounters were recorded onto index cards and entered into a database.

Sampling was conducted in backcountry areas in the upper Merced River corridor (Figure 24). Backcountry areas and trails were segmented as follows:

Wilderness Encounter Sampling Locations	
1B Zone – Trailed Travel	**1A Zone – Un-trailed**
Moraine Dome to Echo Valley	Red Peak Fork
Echo Valley to Merced Lake Ranger Station	Merced Peak Fork
Merced Lake Ranger Station to Washburn Lake	Lyell Fork
Washburn Lake to Junction	South Fork

Figure 24. Wilderness Encounters Sampling Locations.

Several methodological variations in sampling must be noted. First, the monitoring protocol called for the collection of data by a non-uniformed, third-party data collector. However, it was viewed as integral to overall VERP program development to integrate monitoring efforts into existing park operational activities. Therefore, indicator monitoring was conducted by a uniformed backcountry ranger conducting routine patrols. While potential exists for this situation to skew data as some backcountry users may seek out a uniformed Ranger, the likelihood that this occurred to an extent that might have influenced the data is quite low. In a linear trail system encounters will likely occur regardless of intent. Second, due to the remote nature of the backcountry, frequent sampling was not possible, nor was it feasible to include all segments in a single season. Consequently, sample sizes are quite low. This is especially the case with un-trailed zones. Third, the monitoring protocol suggests that the field monitor hike at a speed commensurate to that of the typical hiker roughly 2mph. However, the Ranger generally hiked at a faster pace. Fourth, the question arose as to whether non-uniformed people recognized as employees should be counted. The decision was made to count all hiking parties encountered. Uniformed and trail crews (non-uniformed but obviously working) were not counted as encounters. Additionally, multiple encounters with the same party were not recorded. Finally, the amount of time the ranger left the trail during routine patrols to check campsites or other conditions was not recorded. Therefore, encounter estimates reported here may be conservative as some may have been missed while the Ranger was off trail.

Results: The tables and graphs below present Wilderness encounter rates by trail segment. Tables 19-22 present encounters per hour for 1B Trailed zones in the Merced River backcountry.

Table 19. Encounters per hour from Moraine Dome to Echo Valley.

Date	Encounters / Hour
5/21/2005	0.25
5/23/2005	0.00
6/14/2005	1.33
6/16/2005	1.50
7/10/2005	0.67
7/13/2005	0.50
7/21/2005	2.50
7/23/2005	0.67
7/26/2005	0.50
8/1/2005	4.00
8/10/2005	1.33
8/17/2005	2.00
8/28/2005	0.67
8/30/2005	1.14
9/15/2005	0.50
9/17/2005	0.67
9/22/2005	1.00
9/27/2005	0.50

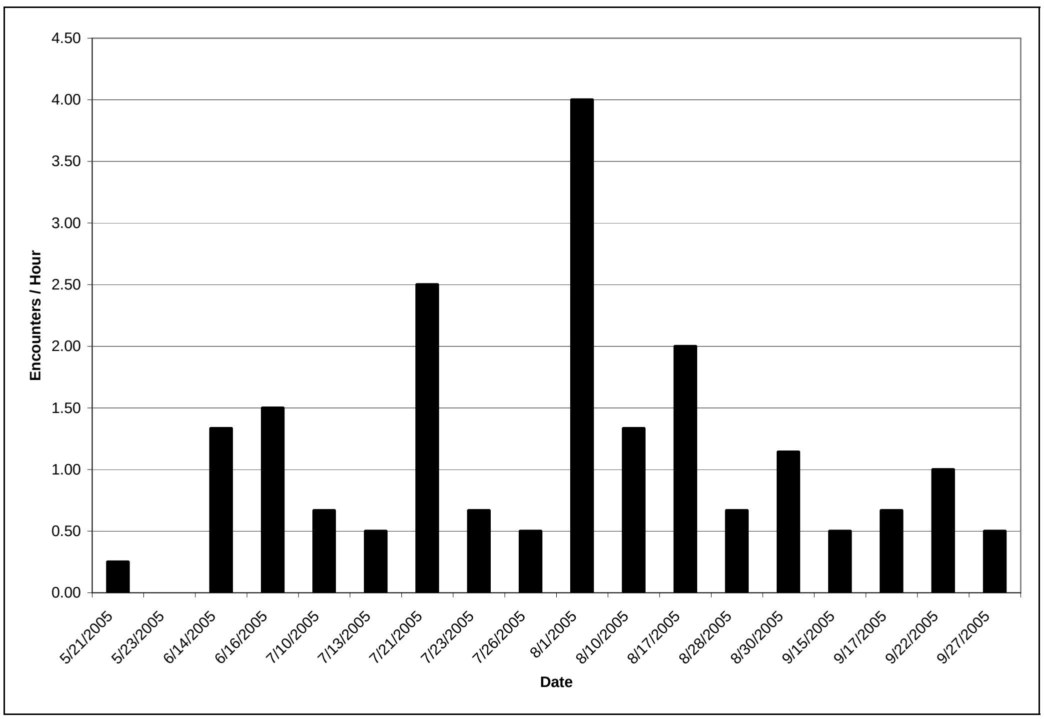


Figure 24. Encounters per hour from Moraine Dome to Echo Valley.

Table 20. Encounters per hour from Echo Valley to Merced Lake Ranger Station.

Date	Encounters / Hour
5/21/2005	0.50
5/23/2005	0.50
6/14/2005	0.50
6/15/2005	0.00
6/16/2005	0.00
7/10/2005	0.50
7/21/2005	0.67
7/23/2005	0.00
7/26/2005	1.33
7/27/2005	0.50
7/28/2005	0.67
8/1/2005	0.00
8/10/2005	0.67
8/11/2005	0.67
8/16/2005	0.00
8/16/2005	2.40
8/17/2005	0.00
8/28/2005	0.50
8/29/2005	0.31
8/30/2005	0.00
9/15/2005	0.40
9/16/2005	1.00
9/17/2005	1.00
9/22/2005	0.40
9/23/2005	0.67
9/27/2005	1.50

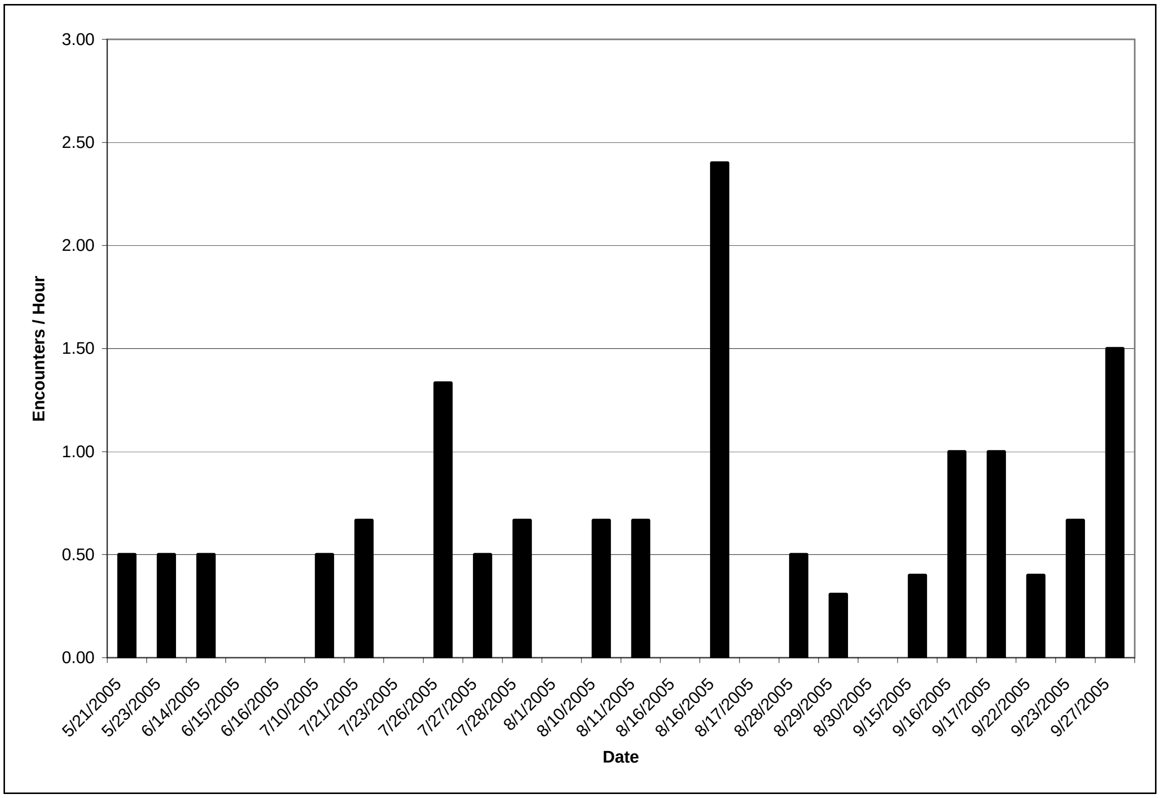


Figure 25. Encounters per hour from Echo Valley to Merced Lake Ranger Station.

Table 21. Encounters per hour from Merced Lake Ranger Station to Washburn Lake.

Date	Encounters / Hour
5/22/2005	0.00
7/22/2005	0.25
7/28/2005	0.33
7/29/2005	0.50
8/12/2005	2.00
8/13/2005	1.00
8/13/2005	0.00
8/14/2005	0.50
8/15/2005	2.00
9/25/2005	0.00
9/26/2005	0.50

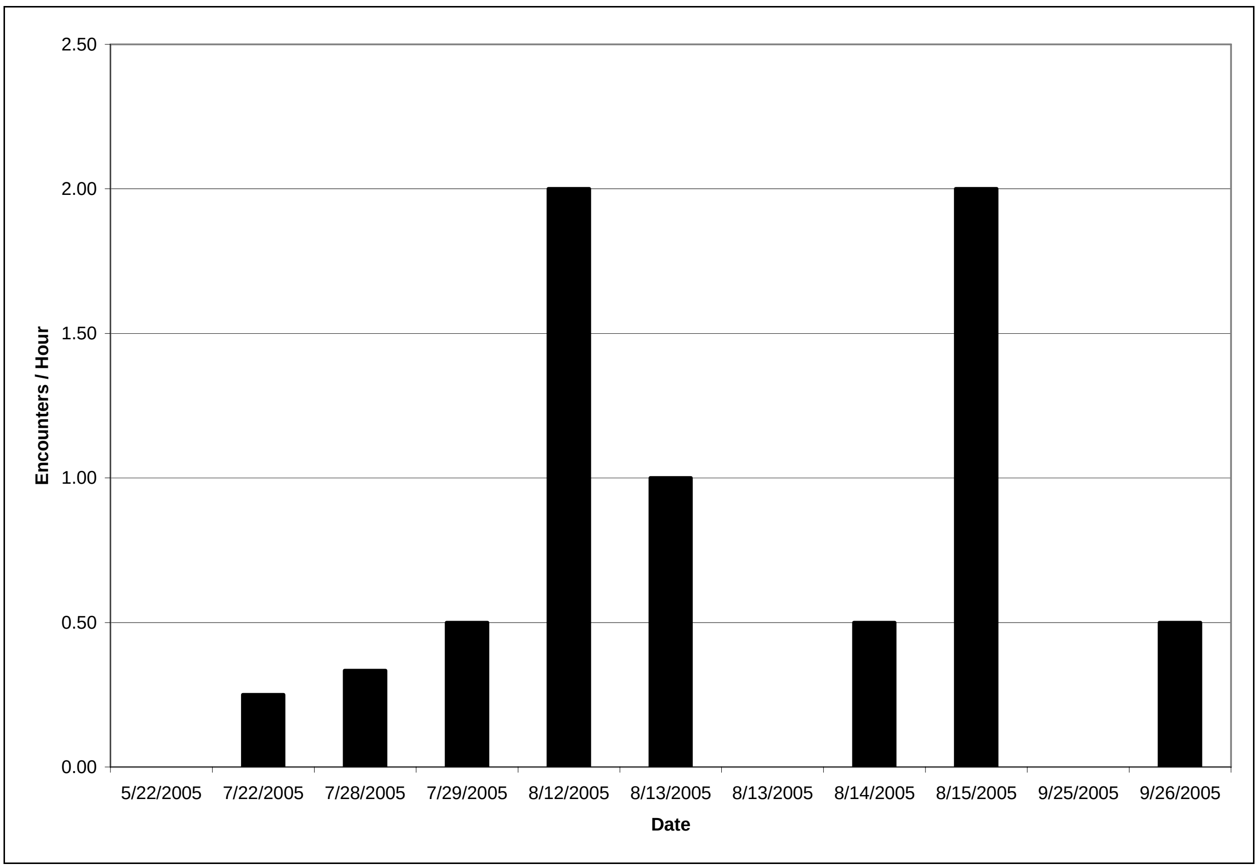


Figure 26. Encounters per hour from Merced Lake Ranger Station to Washburn Lake.

Table 22. Encounters per hour for segments within 1A Un-trailed zones.

Segment	Date	Encounters / Hour
Lyell Fork	8/15/2005	0.00
Merced Peak Fork	8/14/2005	0.00
Merced Peak Fork	9/25/2005	0.00
Merced Peak Fork	9/26/2005	0.00
Red Peak Fork	8/13/2005	0.00
Triple Peak Fork	8/14/2005	0.50
Triple Peak Fork	8/15/2005	0.00
Triple Peak Fork	9/25/2005	0.40
Triple Peak Fork	9/25/2005	0.00
Triple Peak Fork	9/26/2005	0.00

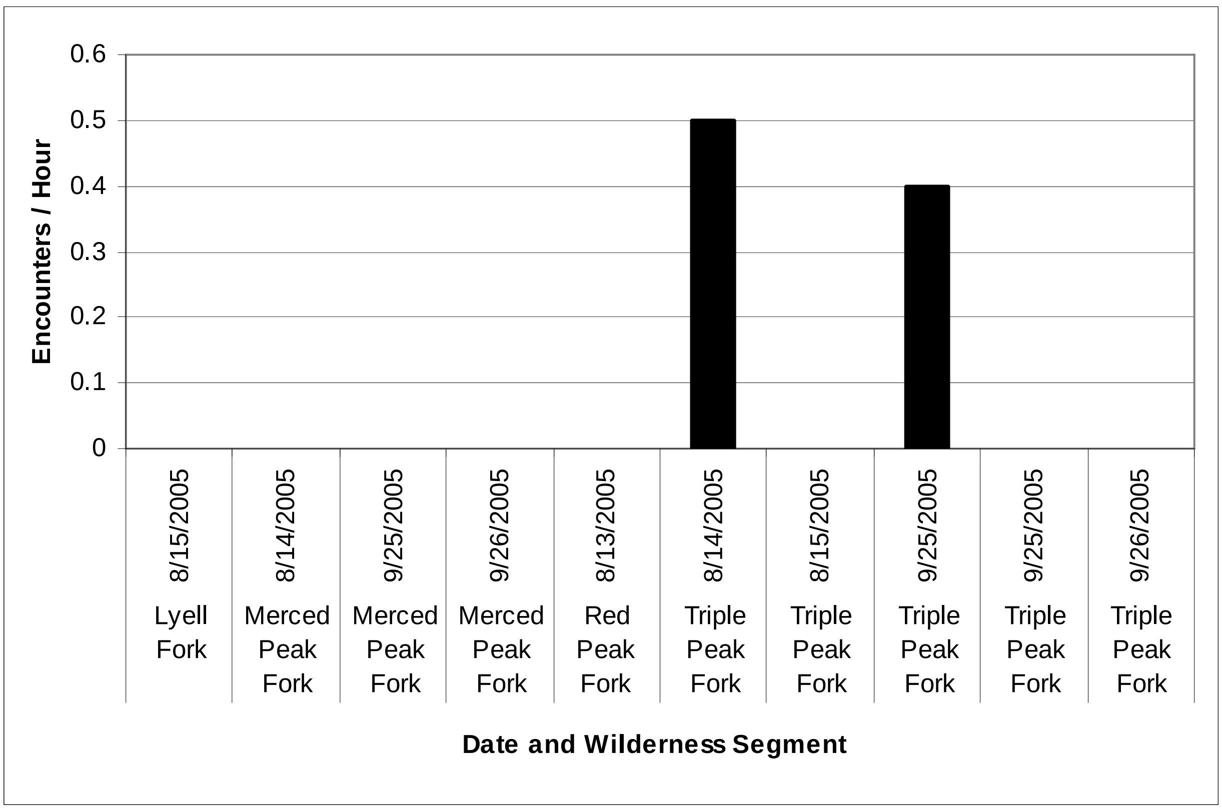


Figure 27. Encounters per hour for segments within 1A Un-trailed zones.

Further analysis was conducted to assess indicator performance and compliance with established standards. Results are shown in the following set of tables and graphs. Tables 23-26 present Wilderness encounter rates by trail segment, while Figures 28-31 show a categorized distribution of encounter rates by trail segment. To calculate overall compliance with standards, the data was considered three ways. First, it was consider by trail segment. One of the segments (Moraine Dome to Echo Valley) exceeded standard this year, with only 63% of the sampling hours showing one encounter per hour or less. Second, it was analyzed without regard to segmentation. By this method, 83% of the sampling hours showed one or less encounters per hour. Lastly, each segment was evenly weighted, without regard for the amount of sampling that occurred there, and the results averaged. By this method, one or less encounters could be expected 87% of the time overall.

Table 23. Wilderness Encounters by Time Moraine Dome to Echo Valley.

Moraine-Echo		
Encounters/hour	**Total time**	**% time**
0	1.00	2%
0.01-.50	12.00	27%
0.51-1.00	15.00	34%
1.01-2.00	12.75	29%
2.01-3.00	2.00	5%
3.01-4.00	1.00	2%
4.01-5.00	0.00	0%
5.01-6.00	0	0%

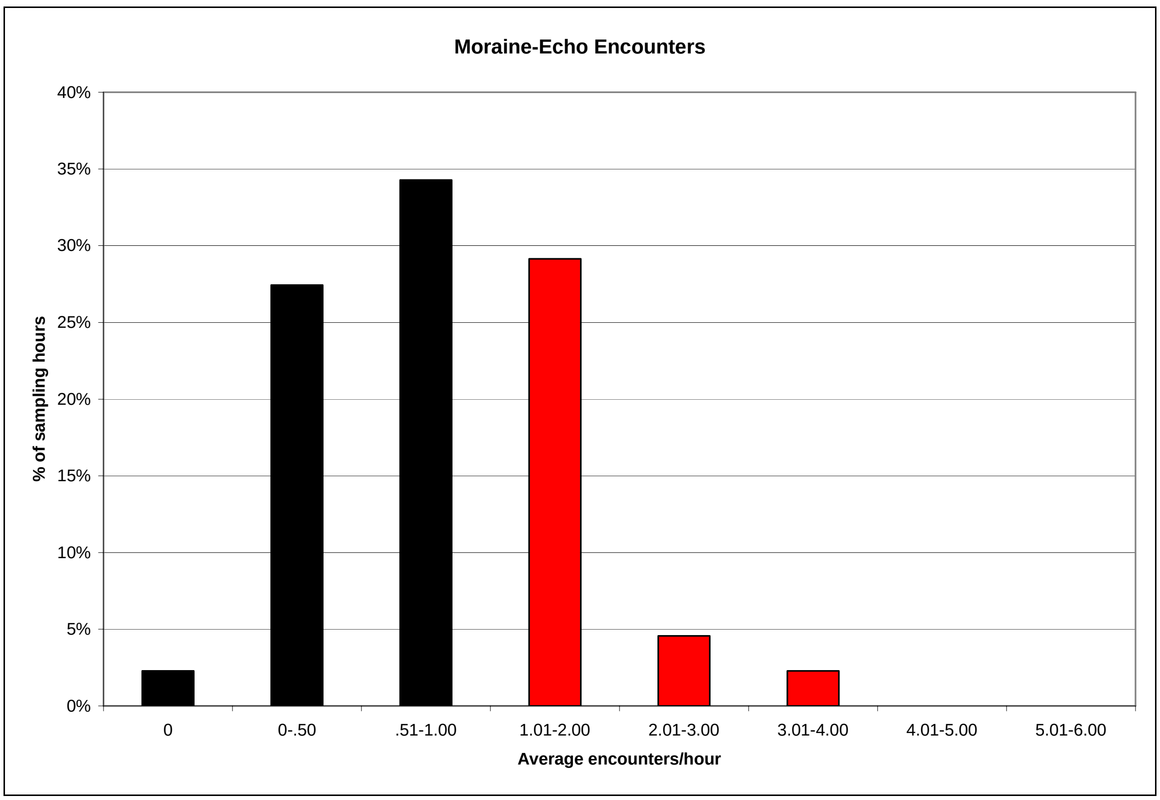


Figure 28. Wilderness encounters by time from Moraine Dome to Eco Valley.

Table 24. Wilderness Encounters by time from Echo Valley to Merced Lake Ranger Station.

Echo-MLRS		
Encounters/hour	**Total time**	**% time**
0	16.75	26%
0.01-.50	23.50	37%
0.51-1.00	17.50	27%
1.01-2.00	5.00	8%
2.01-3.00	1.25	2%
3.01-4.00	0.00	0%
4.01-5.00	0.00	0%
5.01-6.00	0.00	0%

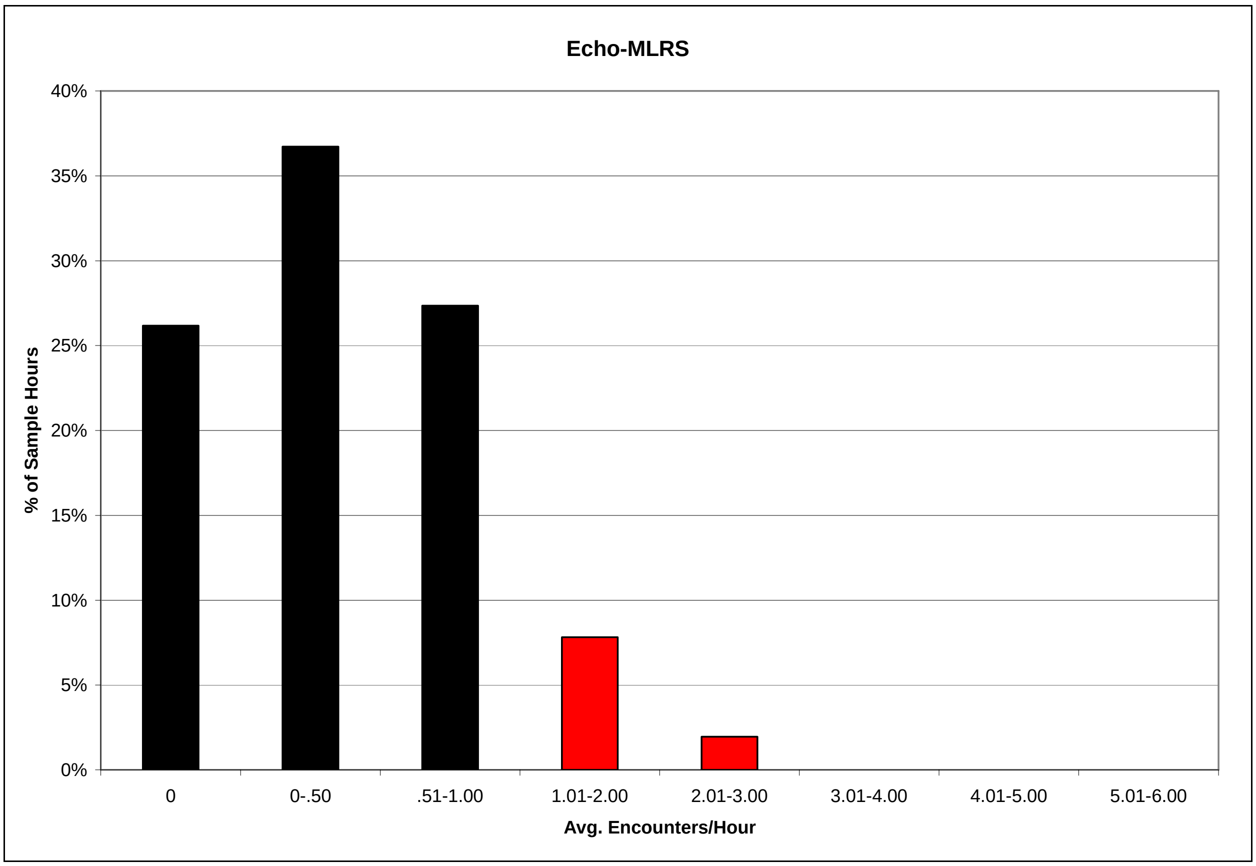


Figure 29. Wilderness encounters by time from Echo Valley to Merced Lake Ranger Station.

Table 25. Wilderness encounters by time from Merced Lake Ranger Station to Washburn.

MLRS-Washburn		
Encounters/hour	**Total time**	**% time**
0	8.00	35%
0.01-.50	13.00	57%
0.51-1.00	1.00	4%
1.01-2.00	1.00	4%
2.01-3.00	0.00	0%
3.01-4.00	0.00	0%
4.01-5.00	0.00	0%
5.01-6.00	0	0%

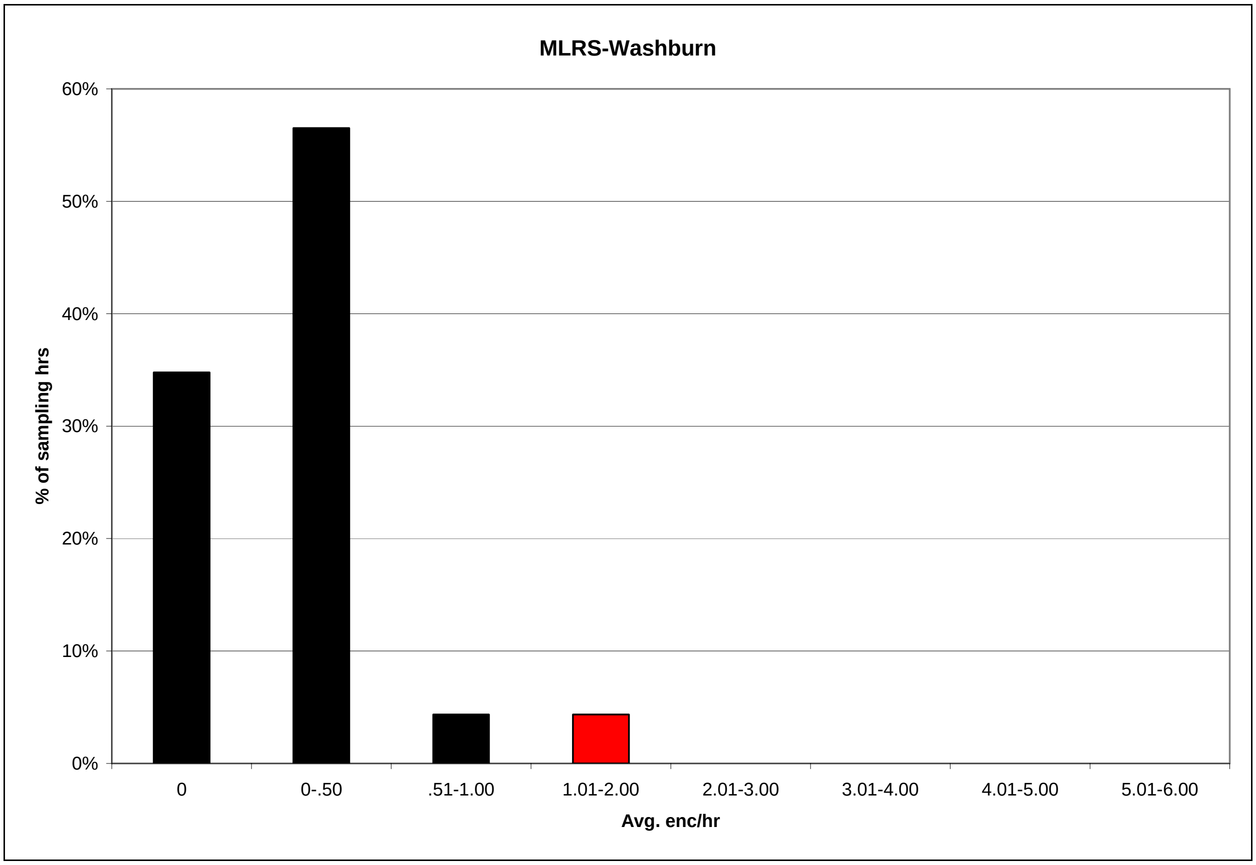


Figure 30. Wilderness encounters by time from Merced Lake Ranger Station to Washburn.

Table 26. Wilderness encounters by time Washburn to Junction.

Washburn-Junction		
Encounters/hour	Total time	% time
0	1.00	100%
0.01-.50	0.00	0%
0.51-1.00	0.00	0%
1.01-2.00	0.00	0%
2.01-3.00	0.00	0%
3.01-4.00	0.00	0%
4.01-5.00	0.00	0%
5.01-6.00	0.00	0%

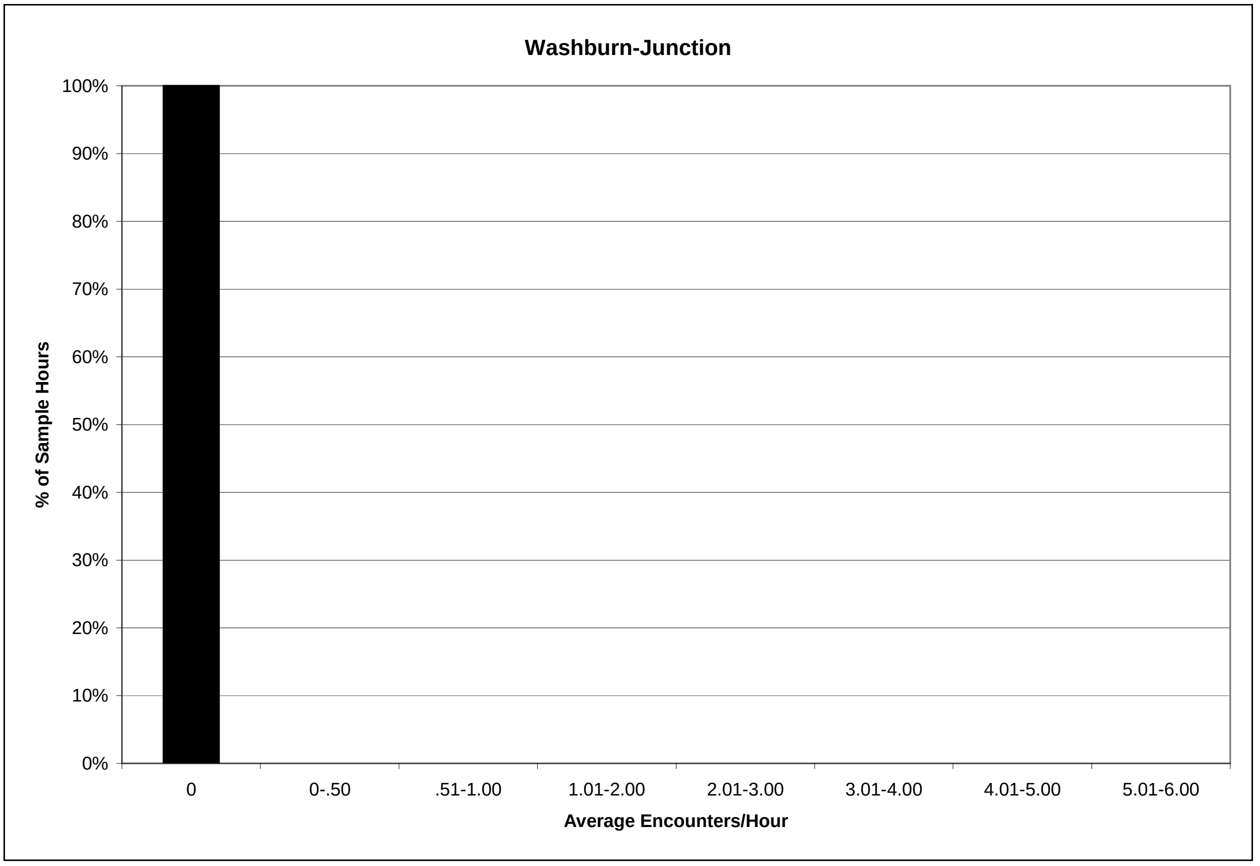


Figure 31. Wilderness encounters by time from Washburn to Junction.

Discussion: The small sample size for this indicator, particularly on one of the trailed segments and for all of the off-trail areas, means that several years will be required to collect a meaningful amount of data. For this reason the off-trail data are presented descriptively and were not analyzed more rigorously. Additionally, results for the trailed data should be considered partial and preliminary. While the sampling protocol has evolved to a useful form, questions remain as to the most appropriate way to both analyze the data and correlate it to relevant research.

2005 should be considered an anomalous year. A deep, lingering snow pack meant a very late start to the hiking season. This may have affected the encounter rate in a variety of ways. For instance, use in the river corridor was probably more concentrated until the higher passes melted out. In addition, the High Sierra Camps never opened. While this may prove useful for future analysis in considering the effect of the camps on encounter rates, it means that use patterns this year were probably far from average.

2.8. PEOPLE AT ONE TIME (PAOT) ALONG THE RIVER

People At One Time (PAOT) is a monitoring methodology that has been applied widely at other parks and protected areas (Manning 1999, Manning et al. 1996, Manning et al. 1998) as well as in Yosemite (Manning et al. 1998, Manning et al. 1999, Newman 2002, Newman 2005) to monitor the effect of human use on the quality of visitors' experience. PAOT is a measure of the number of people present at any given moment in a particular location. For the Merced River PAOT monitoring serves as a "snap shot" of human use activity along the river. These snap shots reflect human use levels and behaviors that may potentially cause negative impacts such as crowding, user conflict, noise and others (Figure 32). PAOT data also serves as surrogate measures of overall human use in the river corridor and helps to inform the extent to which human use may be affecting the Merced River's Outstandingly Remarkable Values.

Figure 32. PAOT along the Merced River.

Measurement: The number of people present within selected 50-meter segments of the river at one time.

Zones:
- 1C Heavy Use Trail
- 2A Open Space
- 2A+ Undeveloped Open Space
- 2B Discovery
- 2C Day Use
- 2D Attraction

Standard: No net increase from 2005 baseline of number of people in River Protection Overlay at selected sites.

Sampling: A stratified sampling methodology was used to obtain a representative sample of river use across the days of the week during peak season from June to September. Three sampling locations were selected representing high, medium and low use areas within the river corridor. At each site the number of people present within a 50-meter section of the river was recorded at one-minute intervals for a period of 60 minutes or 1 hour. Counting periods were also stratified by time of day between 8:00 a.m. and 5:00 p.m. (Table 27). Finally, the number of people was recorded by activity participated in as follows: floating, fishing, swimming, hiking or other.

Table 27. PAOT stratified sampling counts.

Sample Period	Number of One Minute Counts
Weekday Morning	360
Weekday Afternoon	360
Weekend Morning	360
Weekend Afternoon	360
Holiday Weekday Morning	60
Holiday Weekday Afternoon	60
Holiday Weekend Morning	60
Holiday Weekend Afternoon	60

Results: The following are results from the number of people at one time data collection efforts in 2005. Table 28 presents summary statistics on the number of people at one time recorded at each river segment. The average number of people at one time recorded was 0.59 for the low use site, 1.10 for the medium use segment, and 2.97 for the high use segment. The maximum recorded people at one time at each segment were 8 for the low use segment, 12 for the medium and 37 for the high.

Table 28. Summary statistics for PAOT by river segment.

River Segment	N	Mean	Standard Deviation	Maximum
Low	1620	0.59	1.56	8
Medium	1561	1.10	1.93	12
High	1619	2.97	5.49	37

Table 29 presents the total number of people at one time recorded by activity type and river segment. The reader should note that these figures are aggregate counts of persons present each minute recorded during field data collection. Consequently, a person present in a river segment for ten minutes will be represented ten times in these aggregate counts. Nevertheless, these data suggest that floating was the most highly participated-in activity in the river corridor overall. This activity, however, was concentrated in the high use river segment, while hiking was the most participated-in activity in the medium use segment and “other” activities were the most common in the low use segment. Generally, “other” activities included leisure pursuits such as reading, picnicking and others.

Table 29. Total PAOT by river segment and activity.

River Segment	N	Float	Fish	Swim	Hike	Other	Total
Low	1620	0	0	110	387	463	960
Medium	1561	183	22	399	556	555	1715
High	1619	3164	446	166	202	838	4816
Total	**4800**	**3347**	**468**	**675**	**1145**	**1856**	**7491**

Table 30 presents the total number of people at one time recorded by activity type and day. Again, caution should be taken when extrapolating these data as they are aggregate figures. Nevertheless, these data suggest that use is more concentrated on weekends (Friday – Sunday). All activity areas were represented across the types of days sampled with the exception of fishing. Fishing was only recorded on weekdays.

Table 30. Total PAOT by day and activity.

Day	N	Float	Fish	Swim	Hike	Other	Total
Weekend	2219	1374	0	296	631	965	3266
Weekday	2041	1921	468	368	447	842	4046
Holiday	540	52	0	11	67	49	179
Total	**4800**	**3347**	**468**	**675**	**1145**	**1856**	**7491**

Finally, the following graphs present the number of people at one time recorded throughout the course of a typical visitor day at each river segment. Both average and maximum use values are presented here. In general, use fluctuated dramatically from minute to minute with peak use periods occurring in the afternoon hours. Figure 33 presents average PAOT by time of day at the low use river segment. Average use in this segment ranged from 0 to 4 people at one time. Average PAOT peaked between 1:30 and 2:00 p.m.

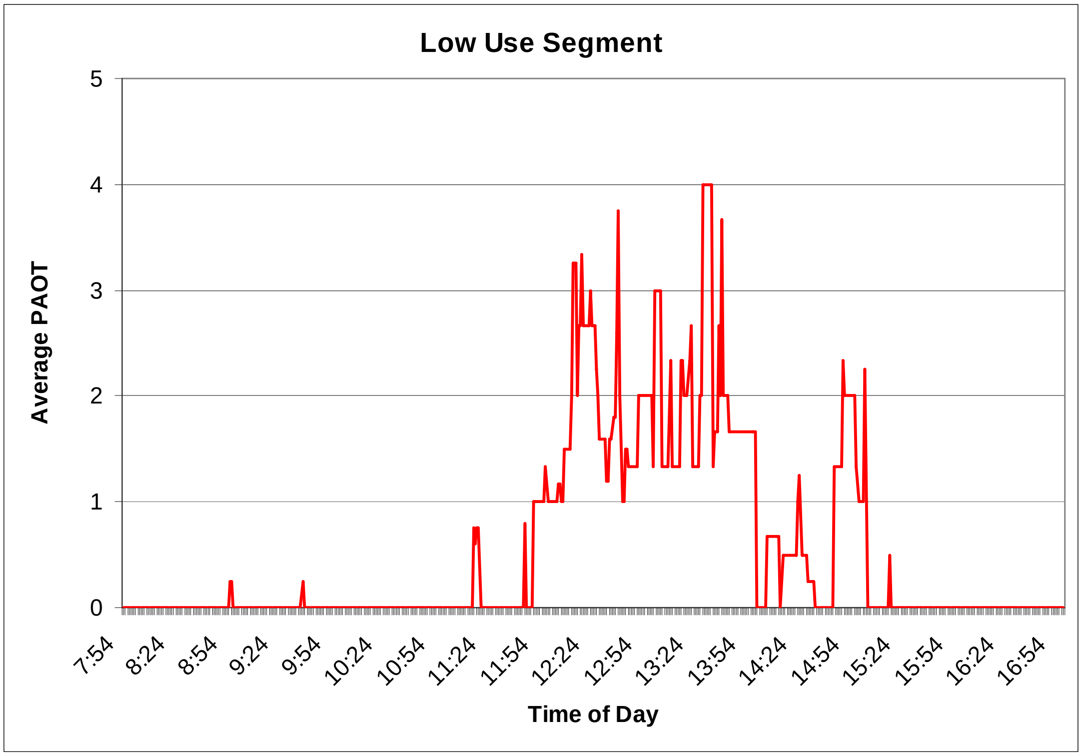


Figure 33. Average PAOT by time of day at low use segment.

Figure 34 presents average PAOT in the medium use segment. Average PAOT in this segment ranged from 0 to 6 people at one time. Average use peaked between 3:00 and 5:00 p.m. at this site.

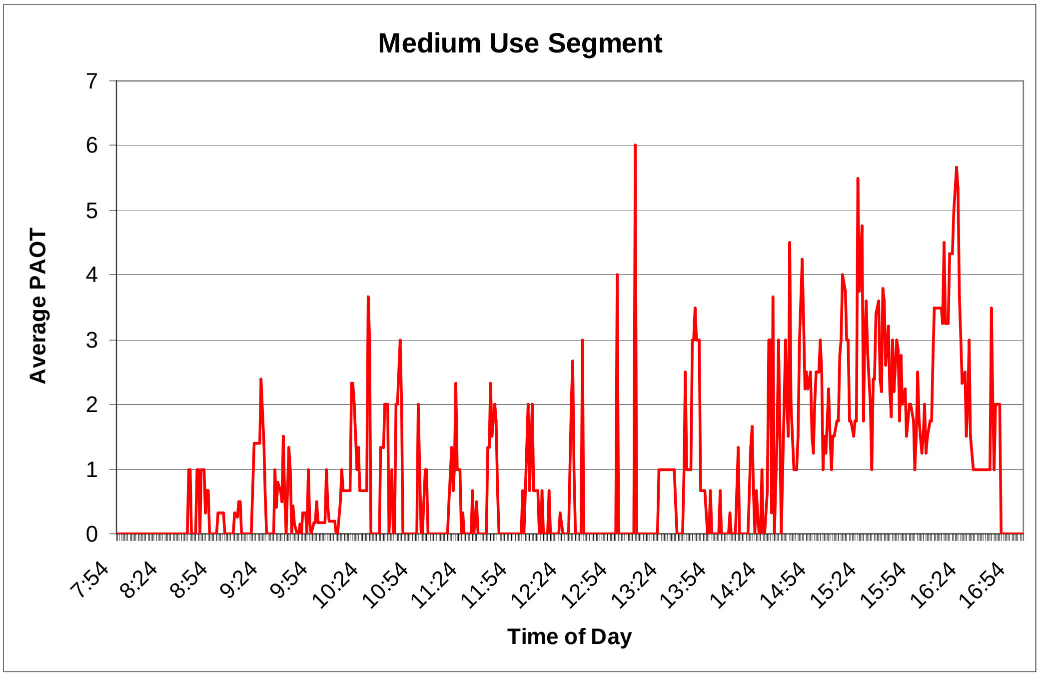


Figure 34. Average PAOT by time of day at medium use segment.

Figure 35 presents average use in the high use segment. Average PAOT ranged from 0 to 13 people at one time. Average PAOT peaked between 2:00 and 3:00 p.m.

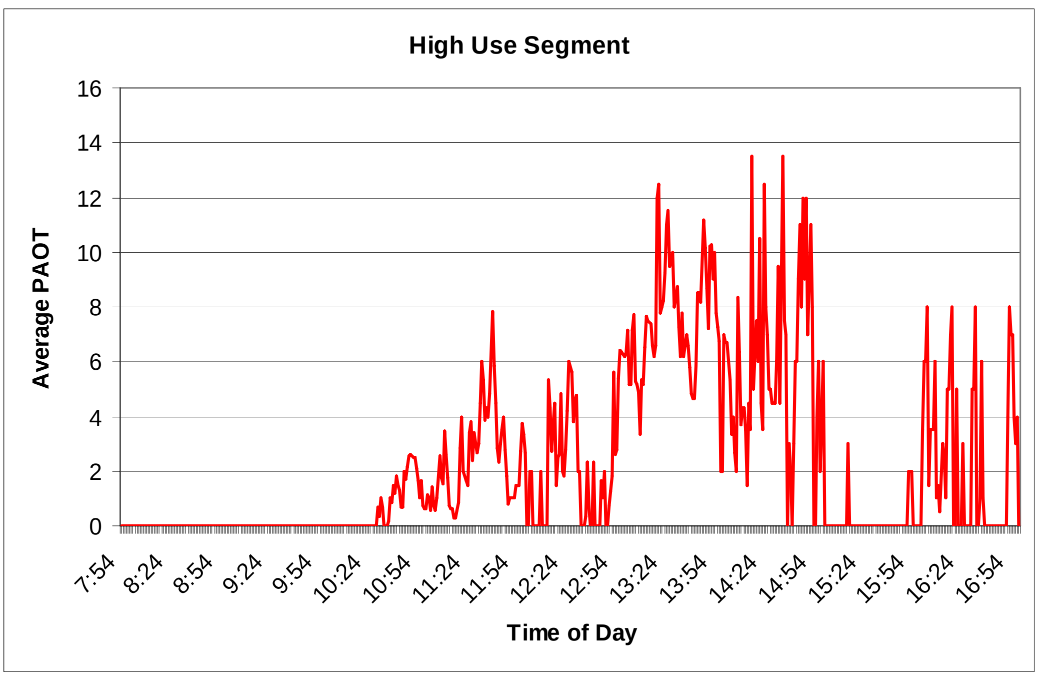


Figure 35. Average PAOT by time of day at high use segment.

The following series of graphs present the maximum number of people at one time recorded throughout a typical day (8:00 a.m. – 5:00 p.m.) at each river segment. Figure 36 presents results from the low use segment where the maximum number of people at one time reached 8. Maximum use peaked between 12:00 and 3:00 p.m.

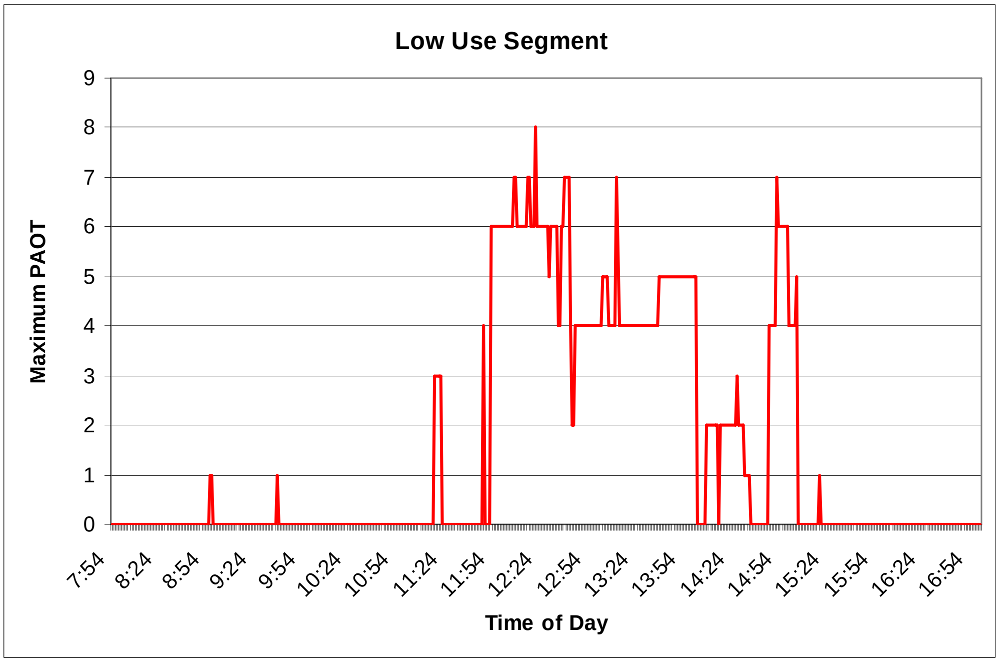


Figure 36. Maximum PAOT by time of day at low use segment.

Figure 37 presents the maximum people at one time recorded at the medium use site. The maximum number of people at one time recorded at this site was 13. Maximum use peaked between 2:30 and 4:30 approximately.

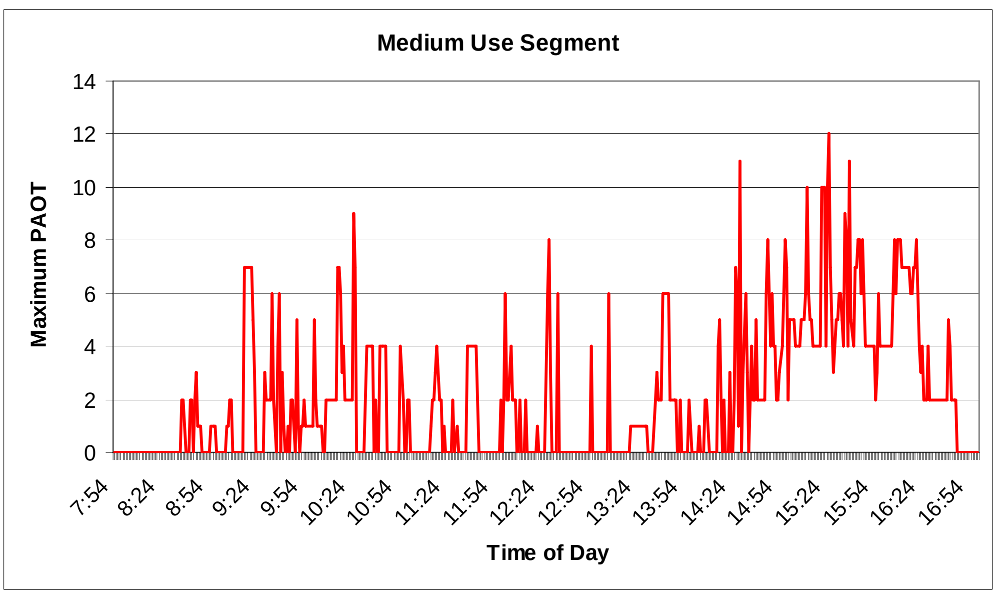


Figure 37. Maximum PAOT by time of day at medium use segment.

Finally, Figure 38 presents the maximum number of people at one time recorded at the high use site. The maximum number of people at one time recorded was 37 with peaks at approximately 11:45 and 2:00 p.m.

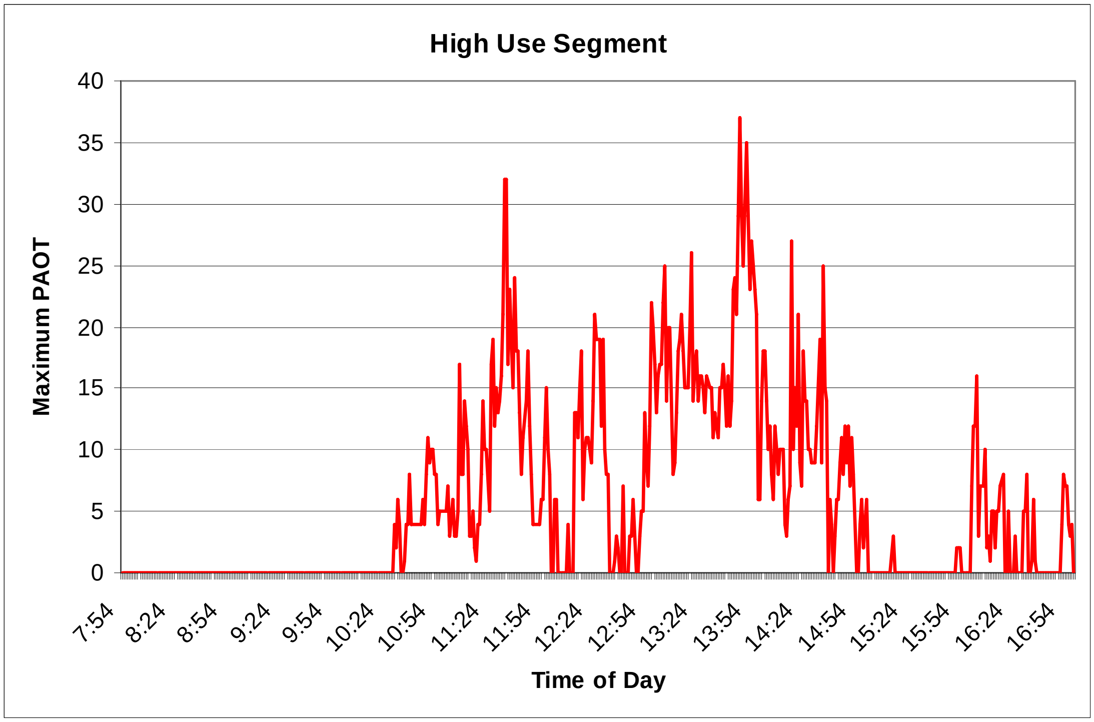


Figure 38. Maximum PAOT by time of day at high use segment.

Discussion: As noted earlier, the number of people at one time fluctuated throughout the course of a typical day. Generally, use is concentrated in the afternoon hours from approximately 2:00 to 4:00 p.m. These hours are generally the hottest part of the day reflecting the high concentration of floaters and swimmers recorded overall.

A comparison of the graphs from each sampling location suggests that the number of people at one time at the medium use segment was more consistent throughout the course of the day than at the low and high use sites. Additionally, the graphs for both the medium and high use segments suggest peaks in use late in the afternoon. This suggests that subsequent data collection efforts may expand the sampling period to later in the day in order to capture this use.

2.9. PARKING AVAILABILITY

Transportation has long played an important role in the National Park system (Percival 1999). Transportation issues have recently been studied at such parks as Yellowstone (Mings et al. 1992), Great Smoky Mountains (Sims et al. 2005), Blue Ridge Parkway (Vallier et al. 2003) as well as in Yosemite (Nelson and Tumlin 2000, YOSE 1999, White et al. 2006). Traffic congestion was identified in the Yosemite Valley Plan as one of the principal human use impacts to mitigate (YOSE 2000).

More than a million vehicles enter Yosemite Valley each year, often resulting in significant traffic congestion. Traffic congestion can cause a variety of impacts to the Merced River's Outstandingly Remarkable Values including the natural and cultural resources as well as the quality of the visitor experience. Specific impacts include increased travel and waiting times, wildlife depredation, air pollution, noise, vegetation loss, and others. Therefore, an indicator was piloted in 2005 measuring the availability of parking facilities at the day use parking area. Parking availability serves as an indicator of overall traffic congestion in Yosemite Valley and, therefore, serves as an early warning sign suggestive of the extent to which the Merced River's Outstandingly Remarkable Values are affected by human vehicular use.

Measurement: Number of instances each month the Camp 6 day use parking area filled to capacity and alternative parking measures were implemented.

Zones:
- 2A Open Space
- 2B Discovery
- 2C Day Use
- 2D Attraction
- 3A Camping
- 3B Visitor Base and Lodging
- 3C Park Operations and Administration

Standards: Standards have not been established for this indicator yet. Results from data collection in 2005 will be used to help formulate appropriate standards of quality.

Sampling: Park Rangers responsible for day use parking recorded the number of instances capacity was reached on a data entry form. Sampling was conducted daily from April to September.

Results: Table 31 presents results from parking capacity monitoring in 2005. Overall, parking capacity at the camp 6 day use parking area filled to capacity the majority of days each month throughout the sampling period. May, June and July received the most days per month when the lot was filled to capacity with 22, 19, and 21 respectively.

However, the reader will note that the total number of cars parked increased from 22,994 in May to 33,379 in July. Additionally, the total number of cars parked per day increased from May to July from 742 to 1097. This suggests that the capacity of the lot varies from month to month. This was most likely due to two related factors. First, the day use parking area is not yet formalized with designated parking spaces. Second, parking management staff did not begin directing parking until June. These factors, along with weather and the types and sizes of vehicles being parked, most likely contributed to a variable parking capacity. Nevertheless, results suggest that capacity at the day use parking lot reached capacity a significant number of days each month throughout the sampling period.

Table 31. Parking capacity indicator results.

Month	Total # of vehicles parked	Average # of vehicles parked / day	Number of days / month lot filled to capacity and alternative parking measures implemented
April	18,631	621	14
May	22,994	742	22
June	24,765	826	19
July	33,980	1097	21
August	29,379	948	11
September	19,498	650	4

Discussion: As previously mentioned, the information provided by monitoring efforts from this indicator variable in 2005 is incomplete. The duration of time each day that the day use parking lot filled to capacity and alternative parking measures put in place was not recorded as was initially intended. Anecdotally, the traffic manager offers that the duration of lot closures lasted between 2 and 3 hours each day, and typically occurred in the afternoon. Future monitoring efforts should adhere to a more rigorous sampling schedule noting the times and durations of lot closures and the implementation of alternative parking measures.

2.10. Facilities Availability

Day use represents a significant portion of human activity in the Merced River corridor. Eating and picnicking are among the most highly participated activities by day users (YOSE 1999). Therefore, a new indicator was piloted in 2005 to measure the availability of day use picnic facilities. The rational for this is that persons not able to find an available picnic table would be displaced to another area and the quality of their experience would be diminished. This also would serve as an additional measure of the capacity and ultimately the effectiveness of the quantity and types of picnicking facilities.

Measurement: The number of available picnic tables versus the total number of tables present at selected outdoor concession food service and park day use picnic areas.

Zones:
- 2C Day Use
- 2D Attraction
- 3B Visitor Base and Lodging

Standards: Visitors are able to find an open table 70% of the time during peak hours – June through October – at outdoor concession food service areas and park day use picnic areas.

Sampling: A stratified sampling methodology was employed to capture a representative sample of outdoor eating and picnic area use throughout the peak season (June – October) in the park. A total of X counts were taken over the course of the season. Sampling sites included the Curry Village Pizza Deck, Cascade Picnic Area, Sentinel Beach Picnic Area and the Texas Flat Picnic Area in Wawona (Figure 39).

Figure 39. Curry Village pizza deck.

Results: The following tables and graphs present facilities availability monitoring results by sampling location.

Table 32. Number of available picnic tables by date and time at Texas Flat.

	6/4/05	6/21/05	7/3/05	7/20/05	8/6/05	8/19/05	9/4/05	9/8/05
11:30 AM	1	5	0	4	4	5	1	4
12:30 PM	3	0	0	0	1	3	0	2
1:30 PM	0	2	0	1	0	5	0	4
2:30 PM	3	2	0	1	1	2	0	4
4:30 PM	4	-	0	3	0	5	0	3
5:30 PM	5	4	0	3	0	1	0	5
6:30 PM	4	3	0	3	3	5	0	4
7:30 PM	4	3	2	4	5	5	3	5

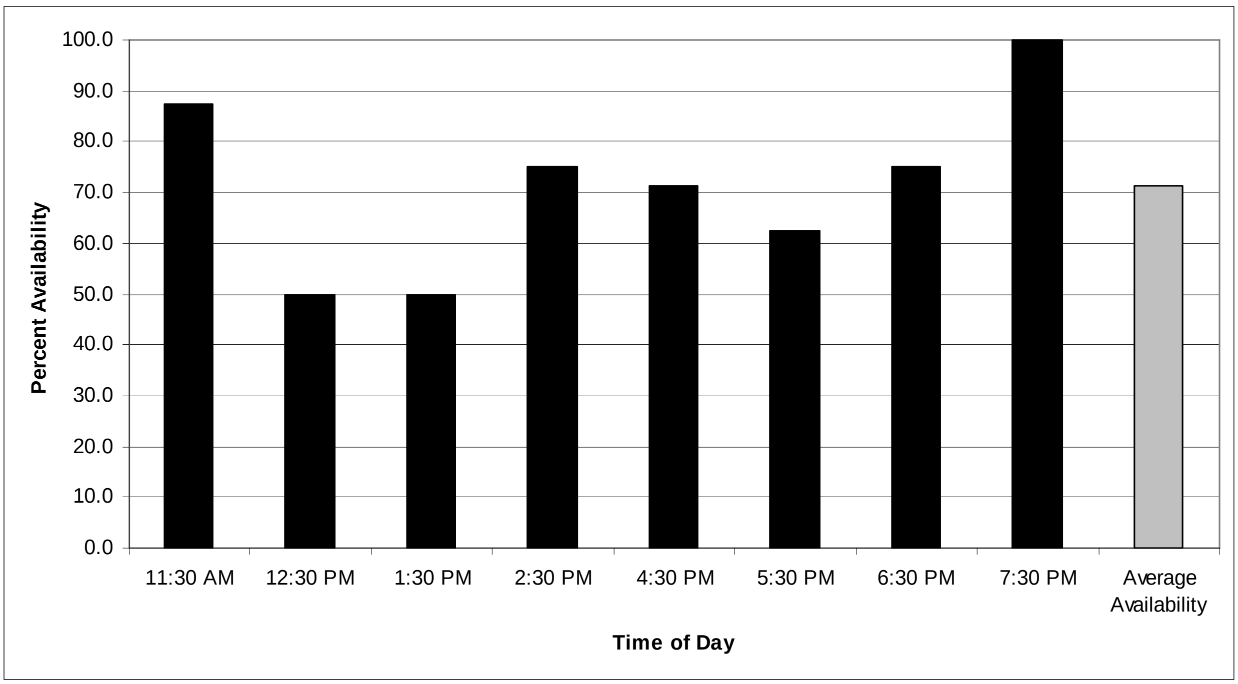


Figure 40. Percent availability of day use facilities by time of day at Texas Flat.

Table 33. Number of available picnic tables by date and time at Sentinel Beach.

	6/5/05	6/17/05	7/3/05	7/11/20	8/13/05	8/18/05	9/3/05	9/6/05
8:30 AM	-	-	-	-	-	9	-	-
9:30 AM	-	-	-	-	-	9	-	-
10:30 AM	-	-	-	-	-	9	-	-
11:30 AM	9	9	3	11	5	8	7	11
12:30 PM	-	8	4	9	4	6	2	9
1:30 PM	3	4	0	8	1	8	0	11
2:30 PM	-	-	-	3	-	7	2	7
3:30 PM	-	-	-	-	-	6	-	-
4:30 PM	5	11	1	12	7	5	10	12
5:30 PM	9	12	2	10	9	-	9	9
6:30 PM	12	11	6	12	12	-	8	11
7:30 PM	12	-	10	12	12	-	10	12
8:30 PM	-	-	-	-	-	-	12	12

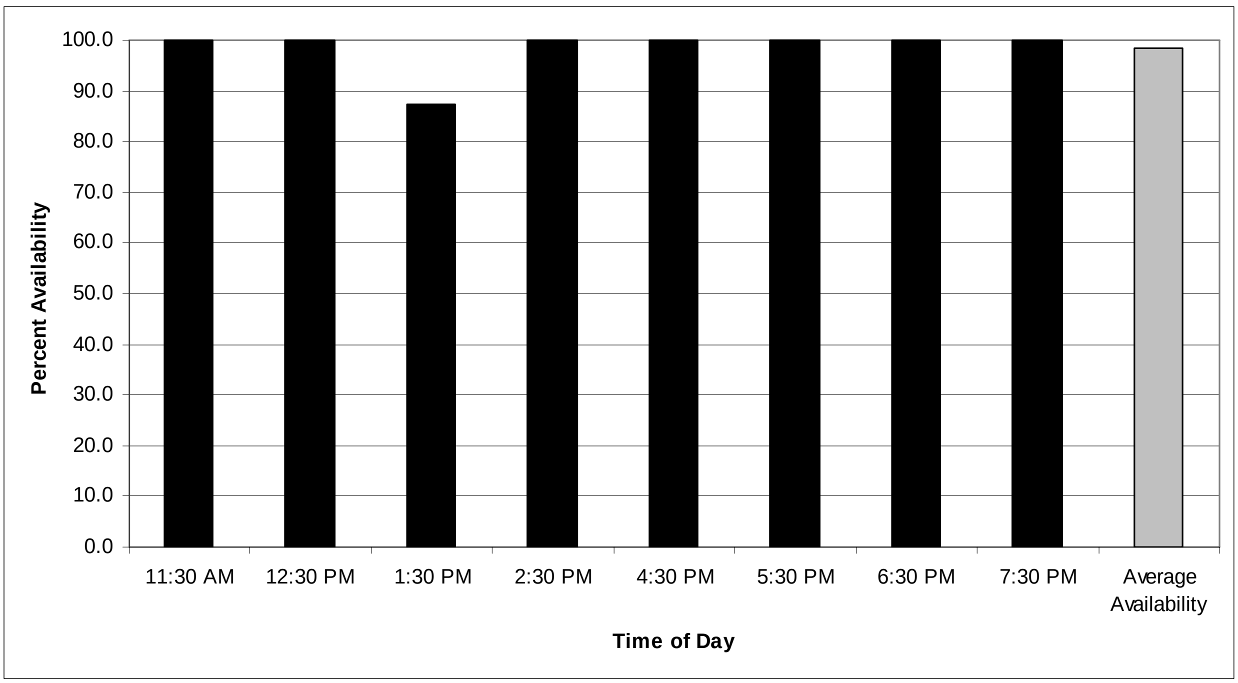


Figure 41. Percent availability of day use facilities by time of day at Sentinel Beach.

Table 34. Number of available picnic tables by date and time at Cascades Picnic Area.

	6/18/05	6/24/05	7/2/05	7/7/05	8/7/05	8/17/05	9/4/05	9/13/05
8:30 AM	-	9	-	-	-	9	-	-
9:30 AM	-	9	-	-	-	9	-	-
10:30 AM	-	9	-	-	-	9	-	-
11:30 AM	6	6	8	8	9	8	5	9
12:30 PM	7	6	4	7	9	8	5	8
1:30 PM	9	9	3	8	6	8	2	2
2:30 PM	-	8	-	-	-	7	-	-
3:30 PM	-	7	-	-	-	6	-	-
4:30 PM	8	9	3	6	3	5	4	8
5:30 PM	9	-	3	6	3	-	4	9
6:30 PM	9	-	7	8	6	-	4	9
7:30 PM	9	-	9	7	9	-	4	9

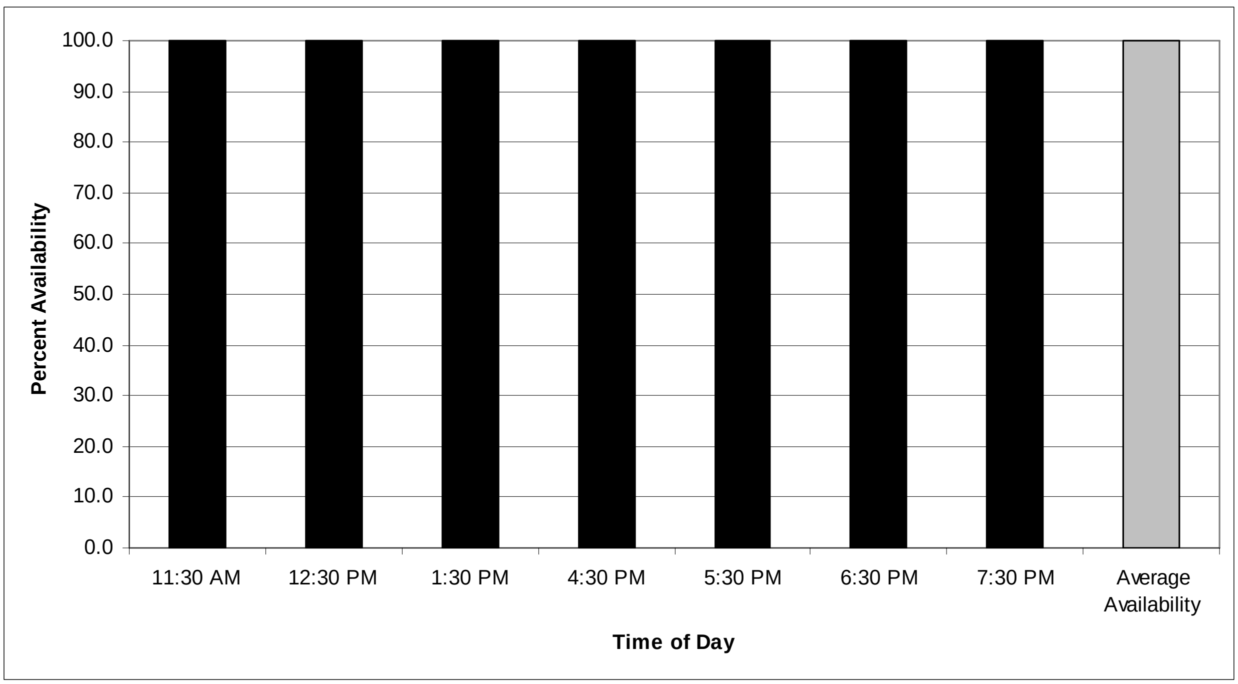


Figure 42. Percent availability of day use facilities by time of day at Cascades Picnic Area.

Table 35. Number of available picnic tables by date and time at Curry Village Pizza Deck.

	6/19/05	6/22/05	7/4/05	8/4/05	8/16/05	8/20/05	9/5/05	9/9/05
8:30 AM	-	-	-	36	-	-	36	-
9:30 AM	-	-	-	36	-	-	36	-
10:30 AM	-	-	-	36	-	-	36	-
11:30 AM	36	36	36	33	-	-	34	-
12:30 PM	-	15	15	16	14	16	7	14
1:30 PM	-	20	12	27	11	9	13	8
2:30 PM	-	-	-	34	-	-	8	-
3:30 PM	-	-	-	34	-	-	14	-
4:30 PM	26	13	17	26	-	-	26	-
5:30 PM	4	4	15	-	14	3	-	14
6:30 PM	5	0	9	-	1	3	-	11
7:30 PM	4	0	1	-	9	0	-	2
8:30 PM	-	-	-	-	3	1	-	3
9:30 PM	-	-	-	-	9	3	-	7

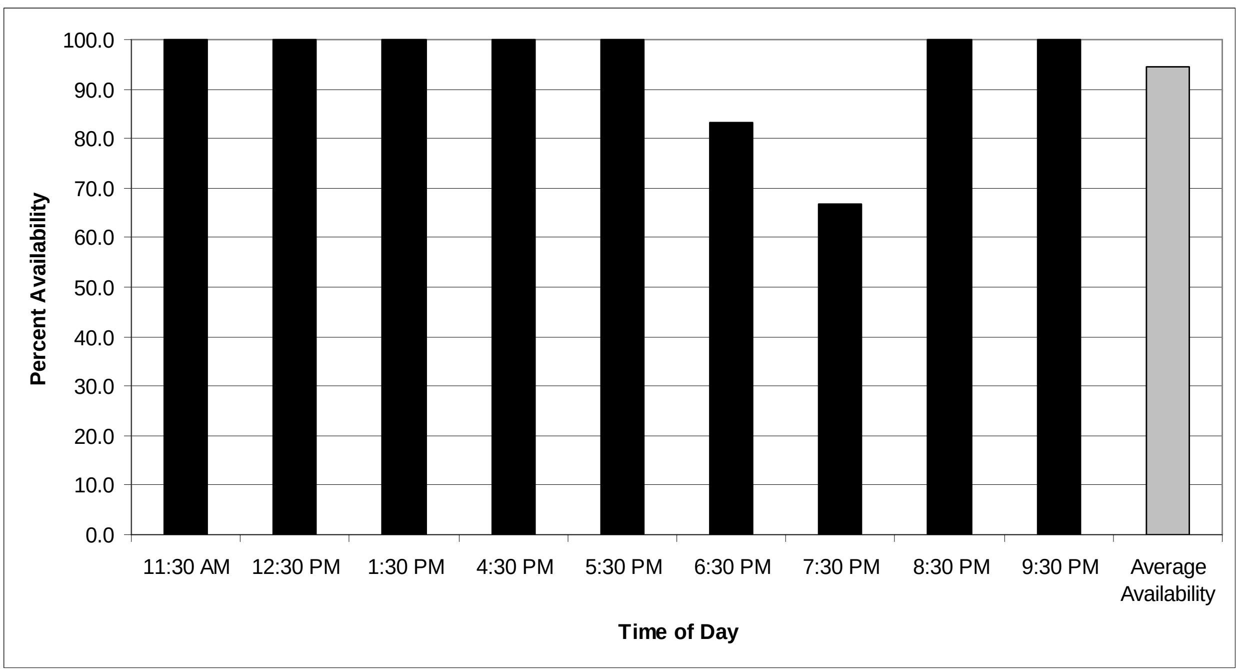


Figure 43. Percent availability of day use facilities by time of day at Curry Village Pizza Deck.

Discussion: The data indicates that visitors are able to locate an open picnic table more than 70% of the time during peak use hours at sampled locations. After sampling and field observation, the results have shown that each sampling location has unique factors that affect availability of picnic tables at the sites as described below:

- *Curry Village Pizza Deck:*

After two days and over 12 hours of observation, peak hours were adjusted to 12:30 pm – 9:30 pm and sampling schedules were altered to reflect these times. Data indicates that tables were on occasion unavailable between 6:30 pm and 7:30 pm.

- *Texas Flat:*

Sampling data and field observation indicate that this location frequently reaches capacity during peak hours and that visitor counts have exceeded seats available at tables. Field observers noted that extended families use multiple tables and that swimmers and boaters park at the site for river access, thereby eliminating access to picnic tables.

- *Sentinel Beach:*

Picnic tables were moved by visitors which required sampling adjustments. NPS Maintenance repaired broken tables and placed them back in service, which required table count adjustments through the sampling period. The concessionaire rafting operation, and associated parking for transport of rafters and boats, may impede visitor access by blocking access to nearby picnic tables.

- *Cascades:*

Picnic tables were moved by visitors which required sampling adjustments. Monitoring of this indicator in 2005 showed relatively high availability of day use picnic facilities. However, some behavioral observations are worth noting here. First, it was observed at several sampling locations that picnic tables were being moved. Some tables were moved closer to scenic vistas such as by the river, while others were moved and combined to accommodate larger groups. This may have affected the outcome of monitoring results. Nevertheless, these observations suggest that facilities may need to be altered to further accommodate visitor needs.

Finally, the methodology employed in 2005 defined an “available” picnic table as one that is entirely un-occupied. This assumes that user groups would prefer to eat at their own table, rather than sharing. Further testing of this assumption may be warranted. Whether seating capacity is determined by the number of individual seats or the number of picnic tables available may produce different outcomes through indicator monitoring. Additional analyses and a review of literature may provide insight into this concern.

3. PROGRAM EVALUATION

The monitoring of indicator variables as described in this document is part of an on-going program to ensure the quality of park resources and visitor experiences. As mentioned earlier in this report, VERP is a planning and management process that focuses on visitor use. The VERP Handbook (NPS 1997) suggests that, "visitor use management begins with a plan, but it continues as a cyclical process involving monitoring, evaluation, and taking action to make adjustments." Monitoring is essential to "close the loop" in this overall process and ultimately inform management actions. Evaluative measures are, therefore, essential to continued VERP monitoring program development and implementation, and to ensure that this program is indeed effective.

Toward this end two workshops were held, one in the spring and another in the fall of 2005, to evaluate and improve upon the VERP monitoring program for the Merced River corridor. The following section presents the results from these workshops. Overall, VERP monitoring program development is expected to be continuous as described in the Handbook. However, it has been recognized that efforts to initiate the program will require more rigorous evaluation and analysis. For this reason, the workshop format has been employed in this the second year since the program's inception. This format is likely to continue in subsequent years until which time the program has been well established.

3.1. SPRING WORKSHOP

A two-day workshop was held on April 7th and 8th, 2005 in Yosemite Valley to evaluate the VERP monitoring program. The objective of this workshop was to refine indicators and standards from the 2004 field season, and to initiate the development of new indicators and standards for the 2005. This workshop was attended by various park service personnel and researchers from cooperating universities.

During the first day of the workshop several new indicators were developed for monitoring in 2005. Previously it was determined that some indicators and standards from 2004 were not robust or reliable enough to be good indicators in the VERP monitoring program (for more information, see the *2004 VERP Annual Report*). Consequently, new indicators were proposed as follows: 1) Exposure of wildlife to human food, 2) Occupied parking versus capacity, 3) Integrity and condition of three traditional plant resources, 4) Number of people involved with recreation activities in the river corridor, and 5) Proportion of day use facilities occupied. For each new indicator the status of the indicator and standard; proposed changes; monitoring methods, and action items were discussed.

Finally, the second day of the workshop focused on refining indicators, standards and monitoring protocols for those indicators from the 2004 field season being carried forward into the 2005 season. Those indicators included: 1) Encounters with other parties in Wilderness, 2) Water quality, 3) People at One Time (PAOT) along trails, 4) Number of social trails, 5) Length of social trails, and 6) Riverbank erosion. Refinements to these indicators and developments for the new indicators previously mentioned were compiled into the *2005 VERP Field Monitoring Guide*.

3.2. FALL WORKSHOP

A second workshop was held on November 16th and 17th, 2005 in Yosemite Valley. Park personnel, cooperating university researchers and other individuals associated with the VERP monitoring program attended the workshop.

The workshop began with an overall evaluation of the monitoring program. Participants were asked to complete a short questionnaire. One item asked respondents to rate overall program performance on a scale from 1 to 10 where 1 = Poor and 10 = Excellent. The average performance rating was 6.9.

Another activity in the workshop evaluated the importance and performance of individual indicator variables monitored in 2005. Known as "Importance-Performance", this technique was adapted from the consumer literature (Martilla and James 1977; Guadagnolo 1985) to evaluate aggregate utility. First, we wanted to know whether the indicators monitored were providing meaningful or important information to inform the protection of park resources and the visitor experience. Workshop participants were, therefore, asked to rate indicator importance on a scale from 1 = "Not at all important" to 5 = "Very important". Second, we wanted to know how well the protocols used to measure indicators performed in providing us with this information. Respondents rated indicator performance on a similar scale from 1 = "Poor" to 5 = "Excellent".

Importance and performance scores were then plotted on a graph such as that presented in Figure 49. In this graph importance is represented on the Y-axis and performance on the X-axis. The graph can be interpreted as follows: an indicator with a high importance and a high performance rating would fall in the top left quadrant of the graph. This area would represent indicators that are important and performing well suggesting minimal refinement. An indicator with a high importance rating, but low performance would fall in the upper right quadrant suggesting that the monitoring protocol needs improvement. An indicator with a low importance and a low performance rating would fall in the bottom left quadrant suggesting that alternative indicators might be considered. Finally, an indicator with a low importance, but high performance rating would fall in the bottom right quadrant suggesting that though the indicator is easily measured, it is not providing information that is important to the program and alternatives might be considered.

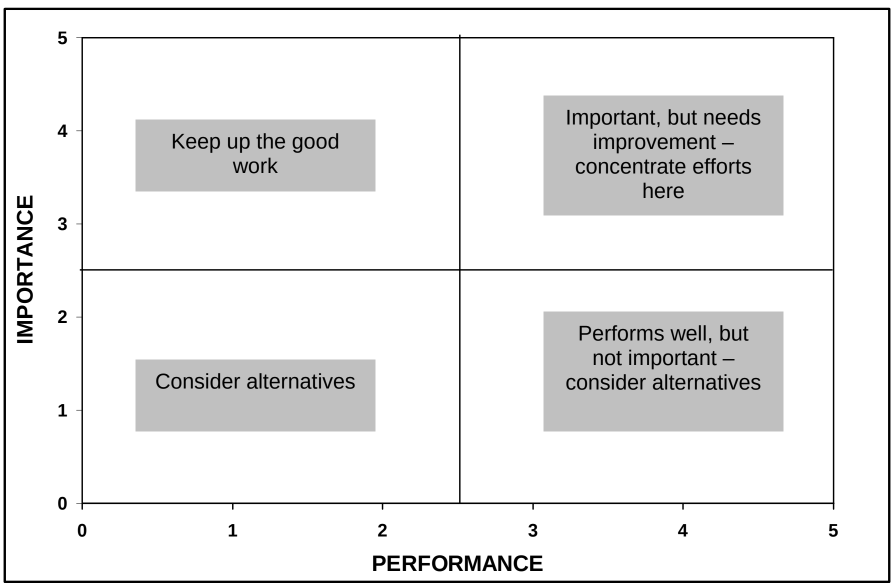


Figure 49. Importance – Performance Matrix.

Each indicator was evaluated individually by meeting participants. Responses were then grouped and plotted on the importance-performance graph. The importance-performance initiated indicator evaluation and served to prioritize our efforts. To further analyze indicator variables workshop participants collectively scored each based on an evaluative matrix provided in the VERP Handbook (NPS 1997). This matrix evaluates each indicator variable based on a series of primary and secondary criteria. Results from this analysis are presented in Table 45 below.

Table 45. Results of Indicator Evaluation Matrix.

Indicators	Primary Criteria								Secondary Criteria							Rating
	Specific	Objective	Reliable and repeatable	Related to visitor use	Sensitive	Resilient	Low-impact	Significant	Easy to measure	Easy to train for monitoring	Cost-effective	Minimal variability	Responds over a range of conditions	Large sampling window	Availability of baseline data	Score (0 - 15)
Facilities Availability		1	1	1	1	1	1		1	1	1			1		10
Number of Social Trails	1		1	1	1	1	1	1	1	1	1		1	1	1	13
Parking Availability	1	1	1	1		1	1	1	1	1	1	1	1	1	1	14
Wildlife			1	1		1		1	1		1	1	1	1		9
Riverbank Erosion				1	1	1	1	1					1	1	1	8
PAOT - Trail	1	1	1	1	1	1	1		1	1			1	1		11
PAOT - River	1	1	1	1		1	1	1	1	1	1		1	1		12
Wilderness Encounters	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Length of Social Trails	1	1	1	1	1	1	1	1	1				1		1	11
Ethnobotany - Scientific	1	1	1	1	1	1		1	1	1	1	1	1			12
Ethnobotany - Practitioner	1	1	1	1	1			1			1		1			8
Water Quality	1	1	1			1	1	1	1	1		1	1	1	1	12

The workshop concluded with a discussion of each indicator variable in more depth. This discussion focused on refinement and improvement of monitoring protocols identifying problems, concerns and other issues related to indicator and standard measurement and performance.

3.3. Recommended Improvements

This section presents programmatic and monitoring recommendations based on field observations and results from the two workshops mentioned above. Specific recommendations for each indicator follow.

Facilities Availability:

- Keep indicator and improve.
- 2005 work identified peak use periods.
- Concern voiced as to the extent to which availability of picnic facilities contributes to the quality of the overall visitor experience.
- Indicator is linked to design of facilities infrastructure.
- Need to analyze day use for trends.
- May be appropriate to count the number of people at each picnic table.
- Recognized existence of at-large picnicking activity (not at designated tables) and potential need to measure the extent to which this is occurring.

Number of Social Trails:

- Discontinue monitoring of this indicator as it overlaps with the Length of Social Trails indicator.
- As measured in 2005, indicator does not map out trails, but only determines their origin. Therefore there is no verification of cumulative trail impact.
- Need to develop integrated trail indicator using trail density.

Length of Social Trails:
- Keep indicator and improve.
- Potential to integrate trail condition assessments. Recommended to change the name of the indicator to *Extent and Condition of Informal and Formal Trails.*
- Include measures of disturbed areas present at the culmination and confluence of social trails.
- May need empirical research and evidence in order to set appropriate standards.

Riverbank Erosion:
- Keep indicator and improve.
- Need to make monitoring more efficient.
- Inventory in 2005 will be used to identify representative sampling sites at which more detailed cross-sectional measurements can be taken in 2006.
- Inventory should be done every 5 to 10 years.
- Utilize total station and digital photography in 2006 methodology.

Ethnobotany:
- Keep indicator and improve.
- Continue practitioner consultation and cooperation.
- Improve communications and identify roles for monitoring activities.
- Suggested conducting social science inquiry / survey related to the quality of the gather's experience.
- Potential to add species such as *Apocynum cannabinum* (dogbane), *Quercus kelloggii* (black oak), and *Scirpus acutus* (tule).
- Need to sample more frequently and on a seasonal basis.
- May be able to discontinue scientific evaluation and focus monitoring efforts on practitioner assessment as this reflects the health and condition of plant resources in addition to usability.
- Practitioner assessments for elderberry and redbud should be done earlier (ideally in September or early October, when berries are ripe). This year's assessment was done too late and the berries had begun to wilt and the leaves were beginning to drop, making the practitioner assessments of health difficult.

PAOT Trails:
- Keep indicator and improve.
- Methodology effective and research exists from which to draw on for improvements. However, social conditions along trails may be more effectively measured by encounter rates.
- Sampling locations questioned. Suggested that use on trail up Vernal Falls concentrates at Half Dome. Suggested moving sampling locations to Half Dome and the original locations included in the Manning study of 1999.
- Suggested conducting counts on Half Dome to initiate application of PAOT monitoring there. Though this sampling site is outside the designated river corridor, it is an iconic recreation attraction and use from the river corridor concentrates on Half Dome resulting in extended waiting times and other impacts there.

PAOT River:
- Keep indicator and improve.
- Concern as to representativeness of sampling sites. Need to be sure monitoring is capturing high use areas and explores for use expansion to previously un-used areas of the river corridor.
- Conducting inventory of river use could inform selection of sampling sites.
- Choose sampling locations that overlap with other indicator variables such as riverbank erosion.
- Need to determine standards of quality. May be able to extrapolate standards from existing literature and research from other areas.

Wildlife Exposure to Human Food:
- Keep indicator and improve.

- Difficulty establishing standards for no-tolerance variables such as food storage regulations. Desire to have 100% compliance.
- Standard could be increased from 95% to 98% compliance.
- Distinction exists between bear incidents (car break-in) and compliance rates. The two may not be highly correlated.
- Need to increase representativeness of sampling.

Wilderness Encounters:
- Keep indicator and improve.
- Monitoring protocol sound, but difficult to implement. Need to increase and improve training and supervision.
- May need different standard to address the effect of use originating from the High Sierra camp at Merced Lake.

Water Quality:
- Keep indicator and improve.
- Sample at several different times of day during the summer to see if increased temperatures and human use later in the day has an effect on concentrations of nutrients and E. coli bacteria.
- Use auto-samplers to sample storm events, and refine the definition of a storm event; a trigger point such as a doubling of discharge during the course of the storm as measured at Happy Isles Gage could be used. Funds were recently secured to examine this aspect of water quality.
- Continue to experiment with sampling using depth integrated samplers versus grab-samples at high water and low water. Grab samples are much easier to collect and less time-consuming. Results of this work in 2005 were encouraging, but more sampling may be necessary to establish grab sampling as being representative of the entire river.
- Enter data on a PDA.
- Measure turbidity upstream and downstream of developed areas.

Parking Availability:
- Keep indicator and improve.
- Monitoring needs to be conducted more rigorously. Need to adhere to protocol more strictly including time and duration of alternative parking measures.
- Capacity of camp 6 day use parking area fluctuated throughout season based on whether traffic and parking were being directed by park personnel. Directed parking was significantly more efficient, resulting in more vehicles parked.
- Explore options to use automated counters and other methods for measuring traffic and parking conditions.

4. SUMMARY

The VERP monitoring program for the Merced Wild and Scenic River completed its second year of implementation in 2005. The first year was a pilot year that focused on preliminary testing and way-finding. This second year, however, has been spent applying the lessons learned in 2004 and continuing to improve and refine the program. This year saw the development of several new indicators and standards; the continued development and refinement of monitoring protocols; implementation of field monitoring activities; and the reporting and distribution of results.

Of particular significance this year was the fact that the VERP monitoring program completed its second full programmatic cycle. In 2004 preliminary standards were established for several indicator variables based on the baseline data collected in that year. For the first time this year results have been compared against these baseline conditions. A comparison of data from 2004 and 2005 has revealed an increase in the total length of social trails in both Cooks and El Capitan meadows. This information will be used to inform management actions. Informed management action closes the loop that characterizes the VERP process. In this way, the VERP program is progressing toward its full performance potential.

Also toward that end has been further progress in formalizing and institutionalizing the VERP monitoring program. The hiring of key personnel and the integration of monitoring activities into park operations were positive developments in 2005. Creating an institutional foundation for the VERP monitoring program will be essential to the program's continued success in the future.

Finally, 2006 will bring new developments and further refinements in the VERP monitoring program. It will represent the third year of monitoring and yet another cycle of the process. This time around, however, emphasis will be placed on finalizing monitoring protocols; integrating monitoring activities into park operations; making monitoring data and information more accessible; and further establishing an institutional basis for "closing the loop" of the process and taking informed management action.

APPENDICES

APPENDIX A: REFERENCES

INTRODUCTION

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